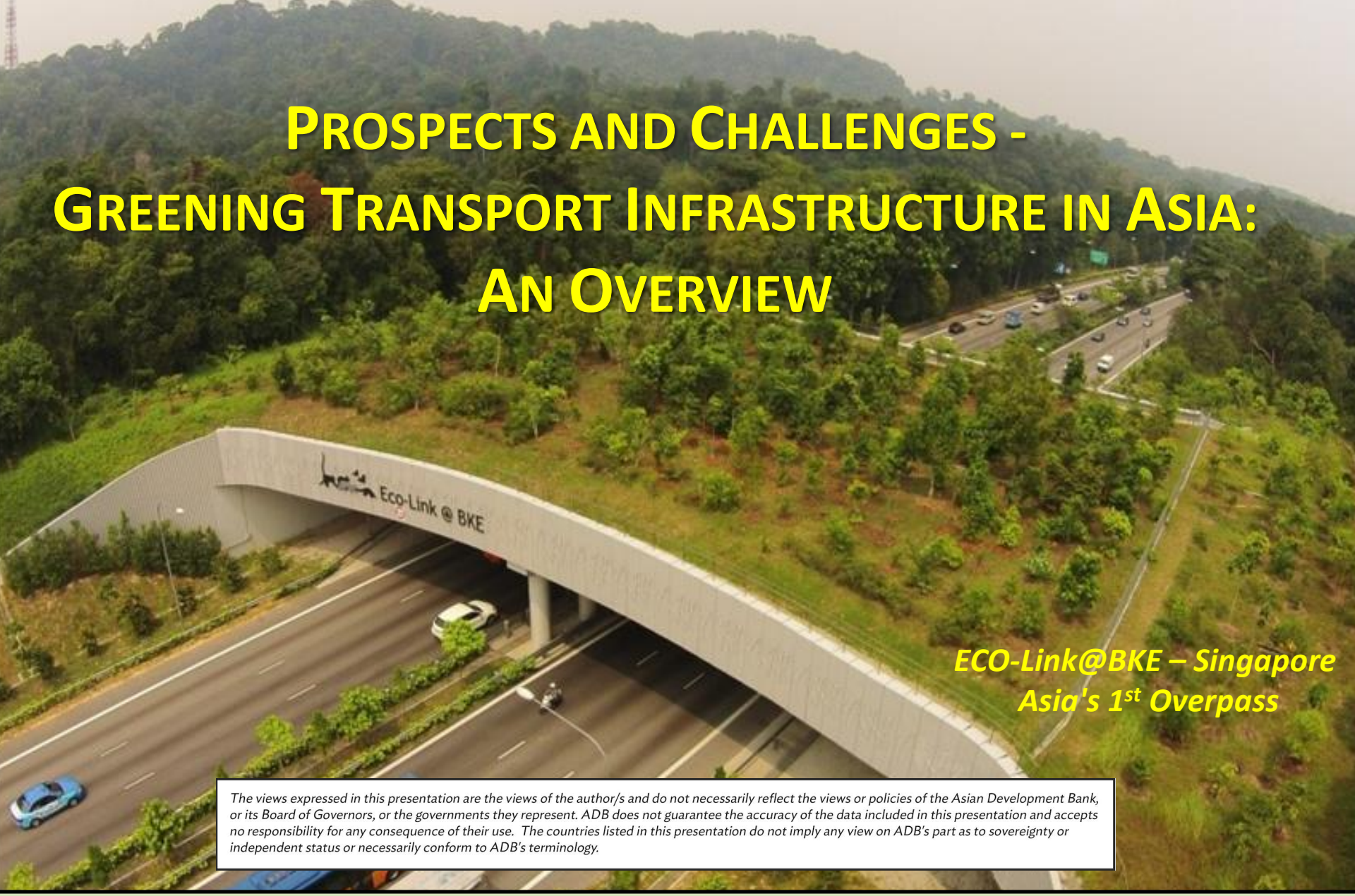
Prospects and Challenges - Greening Transport Infrastructure in Asia: An Overview

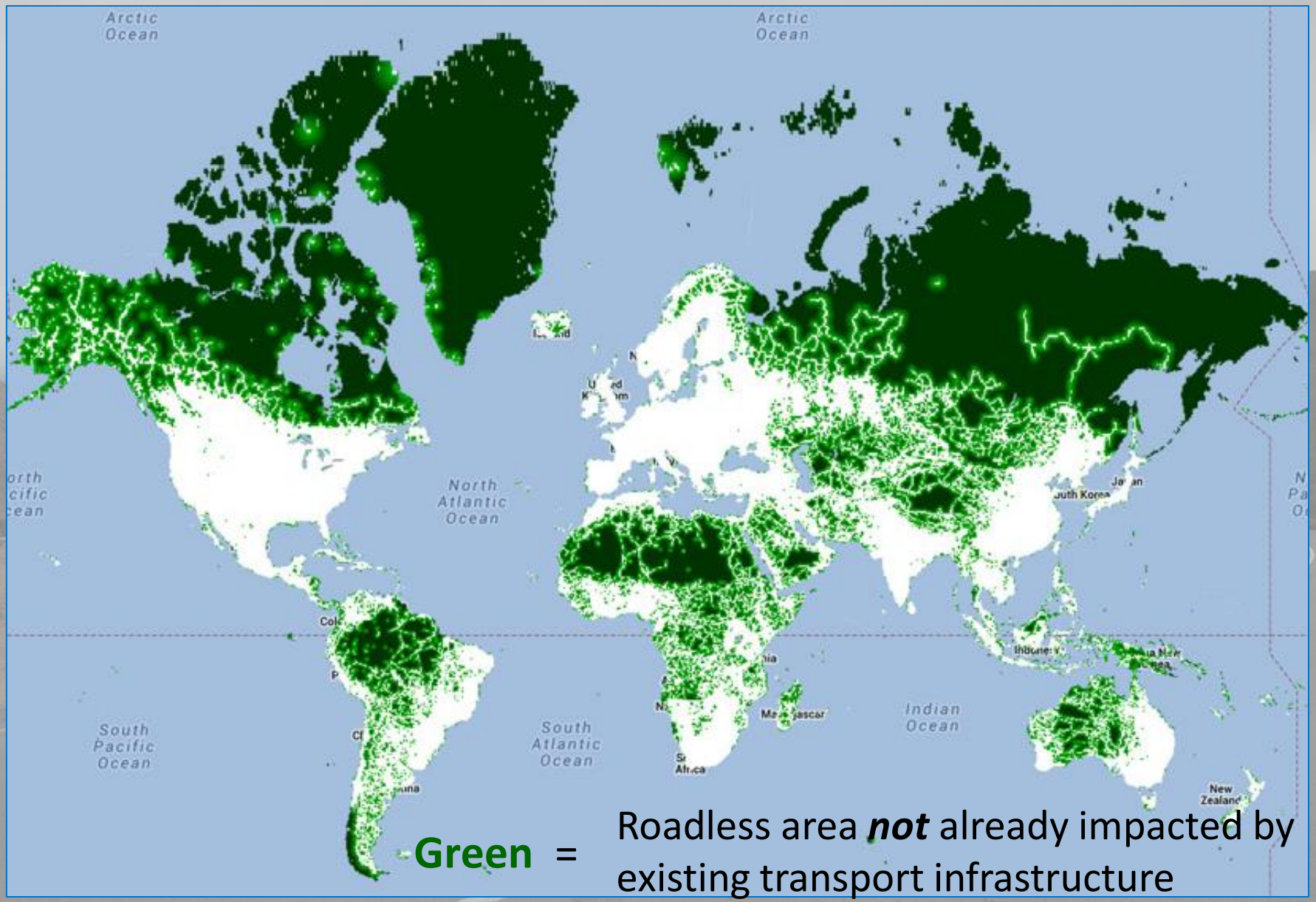


ECO-Link@BKE – Singapore
Asia's 1st Overpass

PLANNING AND IMPLEMENTATION OF GREEN TRANSPORTATION PROJECTS IN SOUTH ASIA
Wildlife Institute of India

Highways constitute one of the most significant forces altering natural ecosystems and impacting biodiversity in the world.*

*Forman & Alexander 1998, Trombulak & Frissell 2000, Forman et al. 2003



Green = Roadless area ***not*** already impacted by existing transport infrastructure

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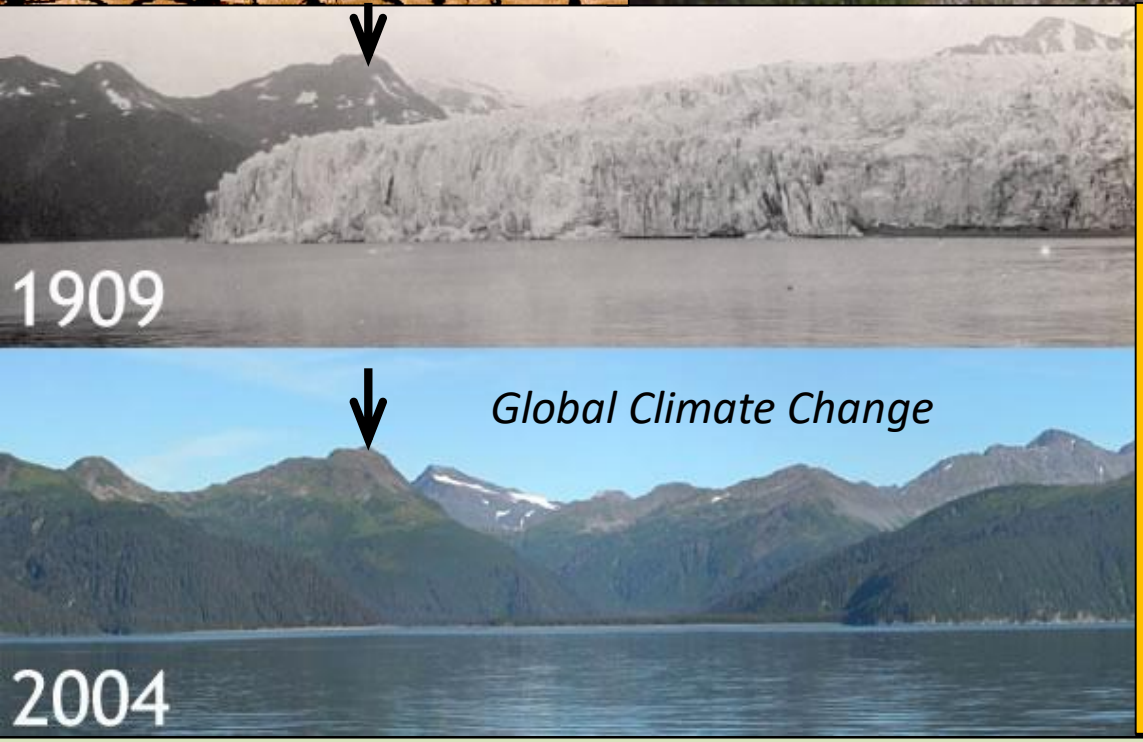

Yet, *unlike* other global environmental threats to biodiversity……

.....linear transport infrastructure project impacts *can be* addressed with scientifically-proven and effective mitigation measures

Asian elephant highway underpass – Southern Bhutan

CHALLENGES TO GREENING ASIA'S INFRASTRUCTURE

- Balancing economic development with conservation of Asia's remaining biodiversity

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- Effective analysis of projects and alternatives, including avoidance of high-biodiversity areas

Will provide a case study from Bhutan on how effective analysis can facilitate the balancing of infrastructure development with biodiversity conservation

CHALLENGES TO GREENING ASIA'S INFRASTRUCTURE

- Balancing economic development with conservation of Asia's remaining biodiversity
- Effective analysis of projects and alternatives, including avoidance of high-biodiversity areas
- Adequate funding for "green" transport projects

CHALLENGES TO GREENING ASIA'S INFRASTRUCTURE

- Balancing economic development with conservation of Asia's remaining biodiversity
- Effective analysis of projects and alternatives, including avoidance of high-biodiversity areas
- Adequate funding for "green" transport projects
- Integrating climate change resiliency
- Effective integration of mitigation strategy elements

EXPERIENCING A "SEA CHANGE" IN JUST 5 YEARS…..

Underpass Openness

Affects amount of light penetrating underpass and view that animals perceive as they look through an underpasses to the other side – need to avoid "tunnel" effects

CASE STUDY

Location: Uttaranchal, India

Culvert "underpass" modified for Asian elephants reported as having minimal use, casting doubt as to whether underpasses will work for elephants

The dimensions of this "underpass" tunnel:

5 m wide × 5 m high × **111 m long**

Openness Index = 0.2 (0.8 minimum)

NEW ELEPHANT UNDERPASSES (2015) – SOUTHERN BHUTAN

Average Openness Index = 5.5

MONITORING OF NEW ELEPHANT UNDERPASSES (2015) – SOUTHERN BHUTAN

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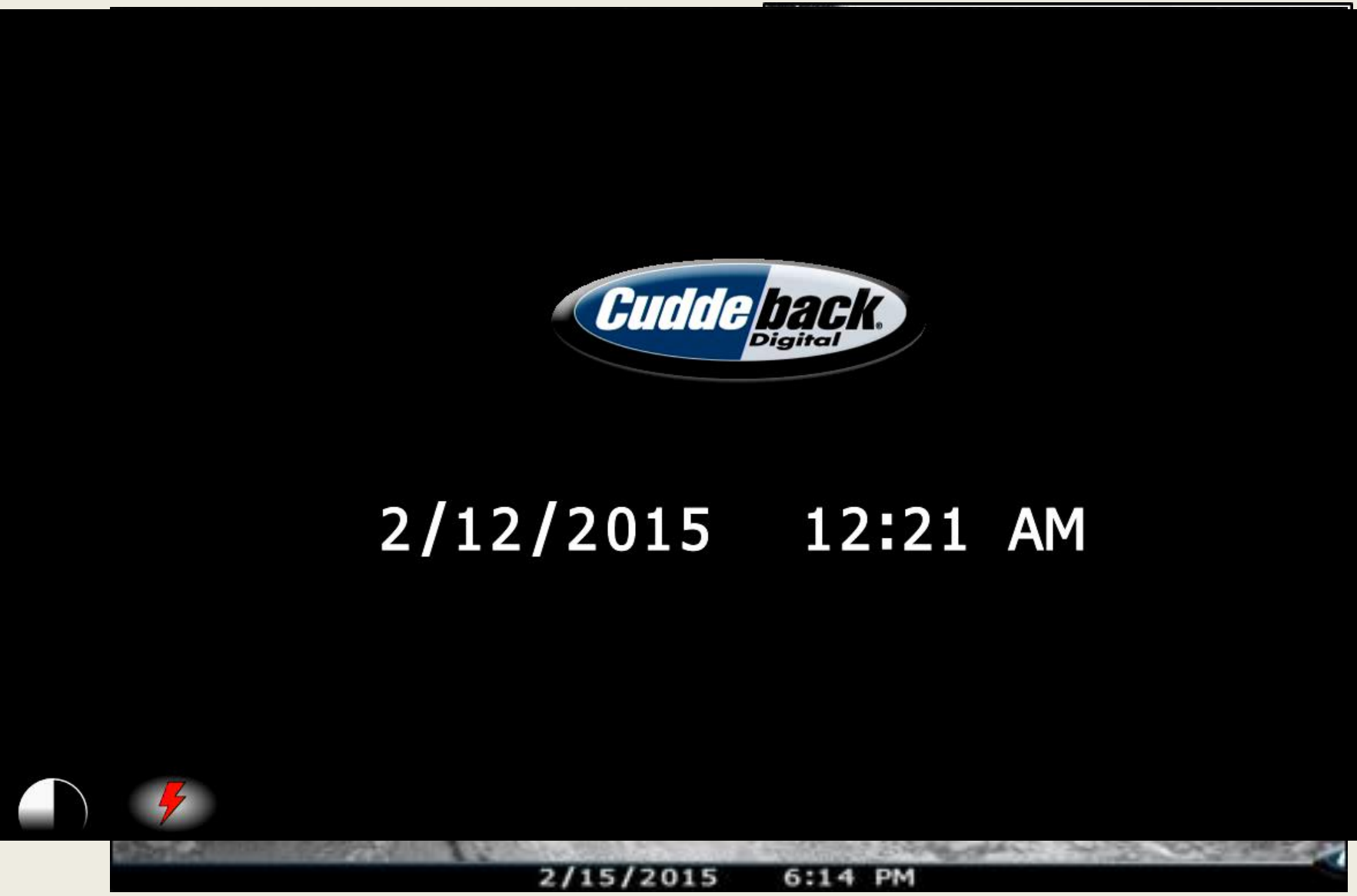
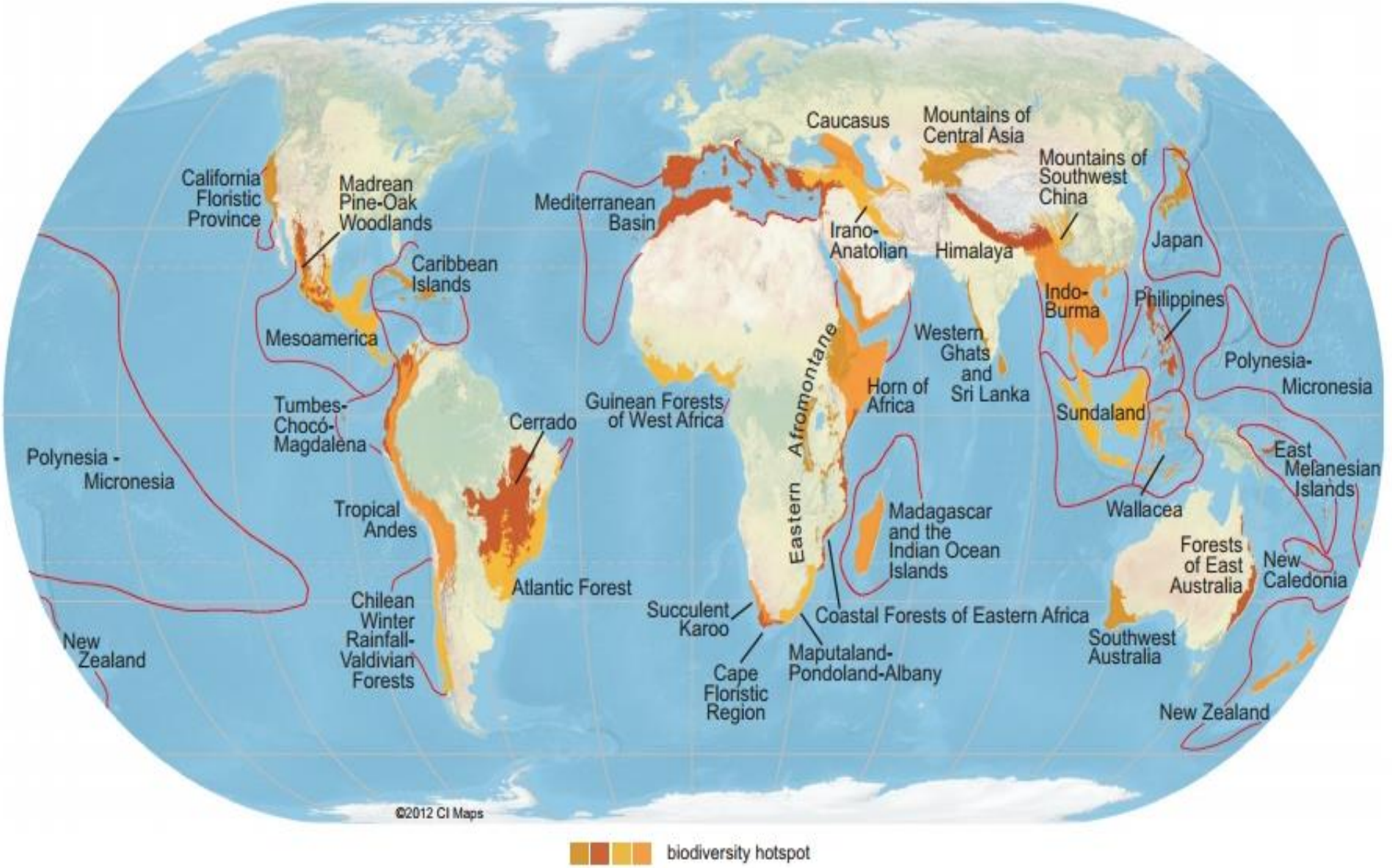


The Overarching Challenge:
BALANCING ECONOMIC DEVELOPMENT AND BIODIVERSITY CONSERVATION

THE WORLD'S GLOBAL BIODIVERSITY HOTSPOTS



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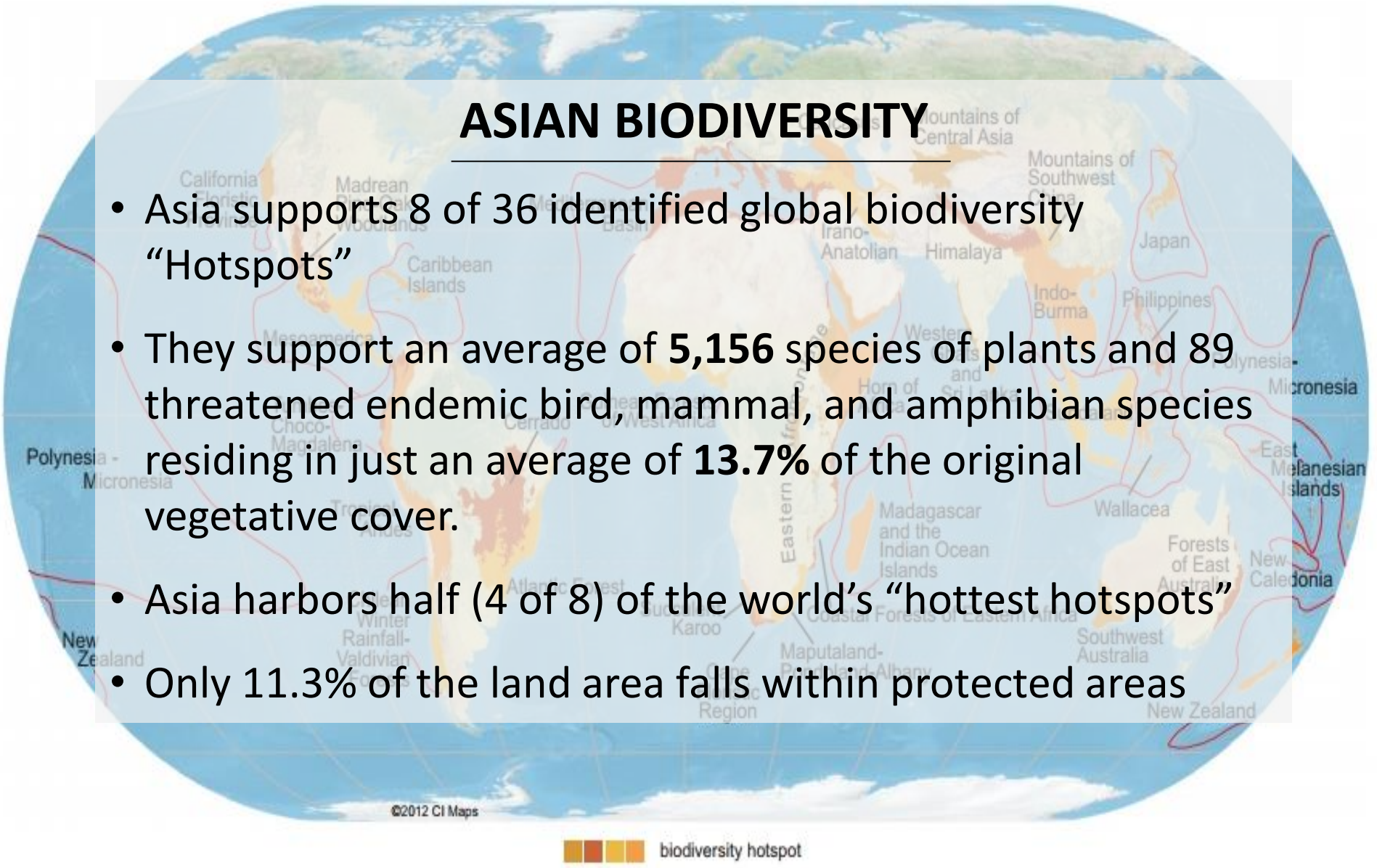


ASIAN BIODIVERSITY

- Asia supports 8 of 36 identified global biodiversity "Hotspots"
- They support an average of **5,156** species of plants and 89 threatened endemic bird, mammal, and amphibian species residing in just an average of **13.7%** of the original vegetative cover.
- Asia harbors half (4 of 8) of the world's "hottest hotspots"
- Only 11.3% of the land area falls within protected areas

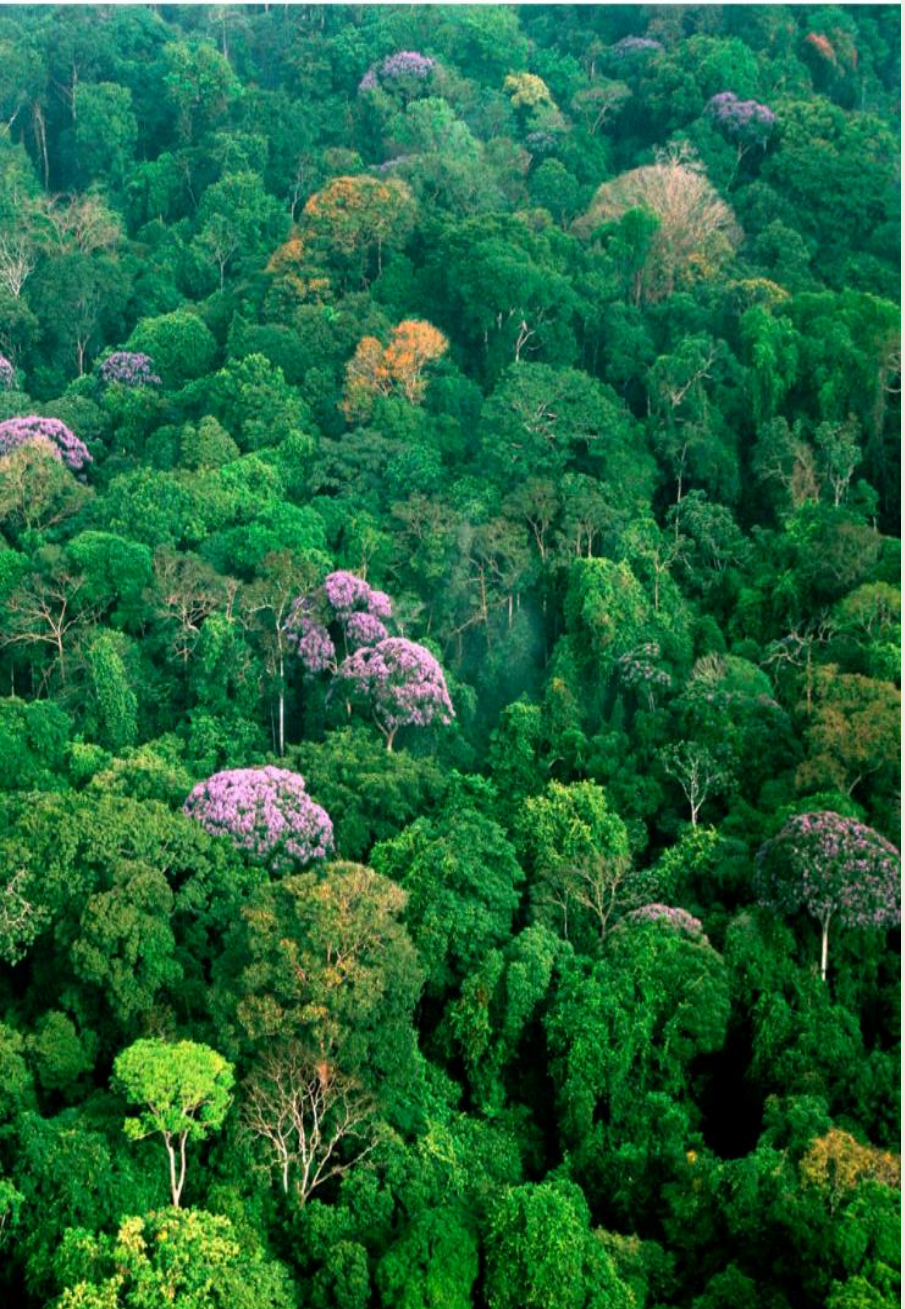
Much of Asia's terrestrial biodiversity is concentrated within tropical rainforest-dominated landscapes

- 2,035 Asian *Key Biodiversity Areas* (KBA) account for 95% of all globally IUCN threatened and endangered species
- Just 16% of KBA are fully encompassed within protected areas and thus remain vulnerable

FOREST LOSSES AND BIODIVERSITY

- Asia has lost 2/3 of its original tropical forest vegetation (MacKinnon 2002), 1/3 between just 1980 and 2000
- Within Asia's 8 biodiversity hotspots, the losses have been even higher—an average **83%** of the original vegetated habitat has been lost
- Asia's tropical forests continue to experience some of the highest annual deforestation rates of any reported in the world (>3%/year in some places)

FOREST LOSSES AND BIODIVERSITY EXTINCTIONS



The Western Ghats/Sri Lanka hotspot, Asia's smallest, has recorded **20 species extinctions** (more than the other 7 combined)

Based on historic trends in forest destruction, Brook and Sodhi (2003) estimated that of all mammal species native to Southeast Asia, **21%-48%** are on trajectories toward extinction by the year 2100

NEW ROADS AND FRAGMENTATION

- Roads are regarded as a “gateway” to the loss of biodiversity within roadless areas. *Unplanned* roads can facilitate habitat destruction, illegal hunting, and human settlement
- Most rapid rates of deforestation occur with 10 km of roads, especially if they are paved (Selva et al. 2015)
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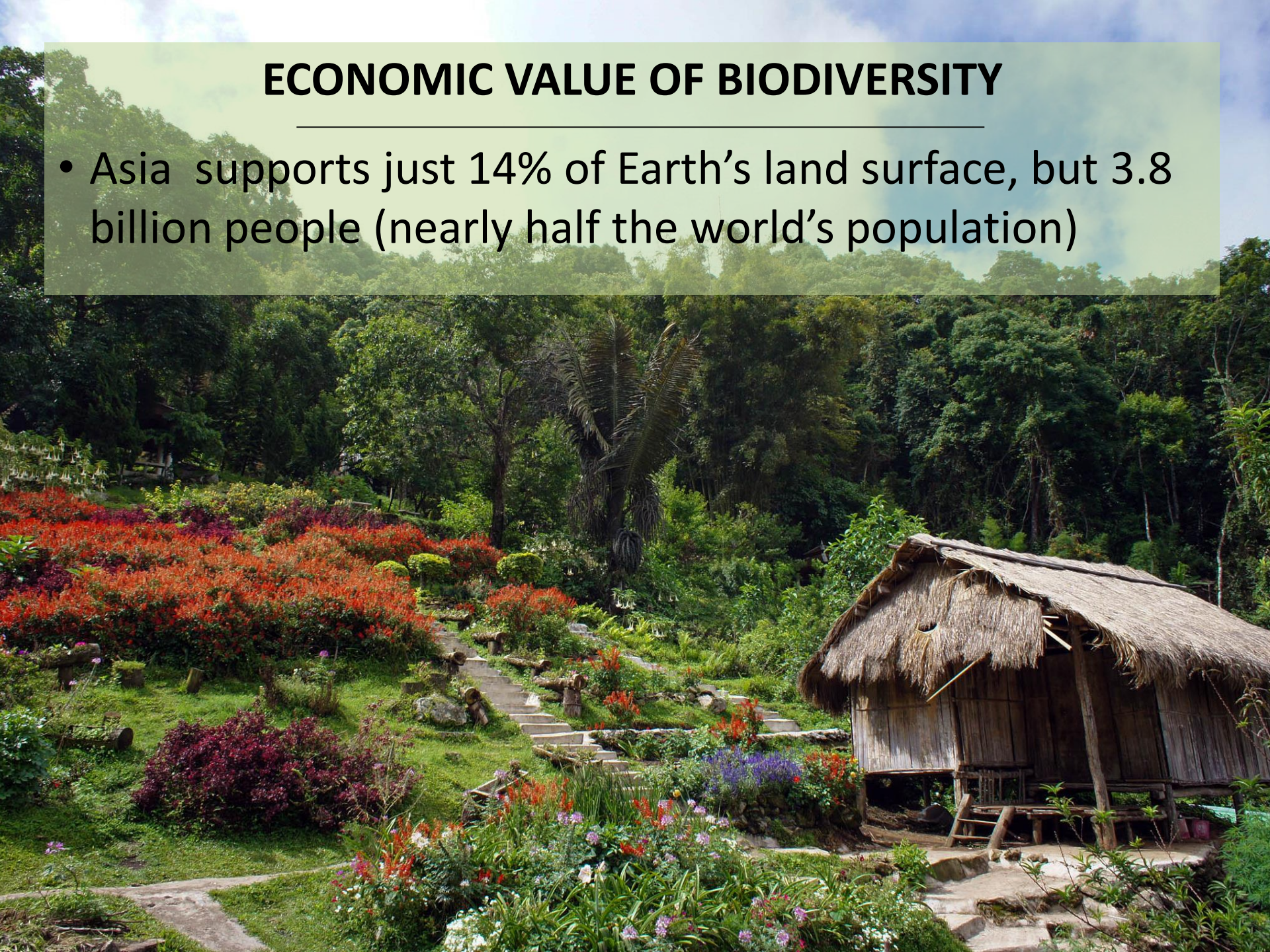
WE CAN, AND MUST DO BETTER THAN THIS!

ECONOMIC VALUE OF BIODIVERSITY

- Asia supports just 14% of Earth's land surface, but 3.8 billion people (nearly half the world's population)



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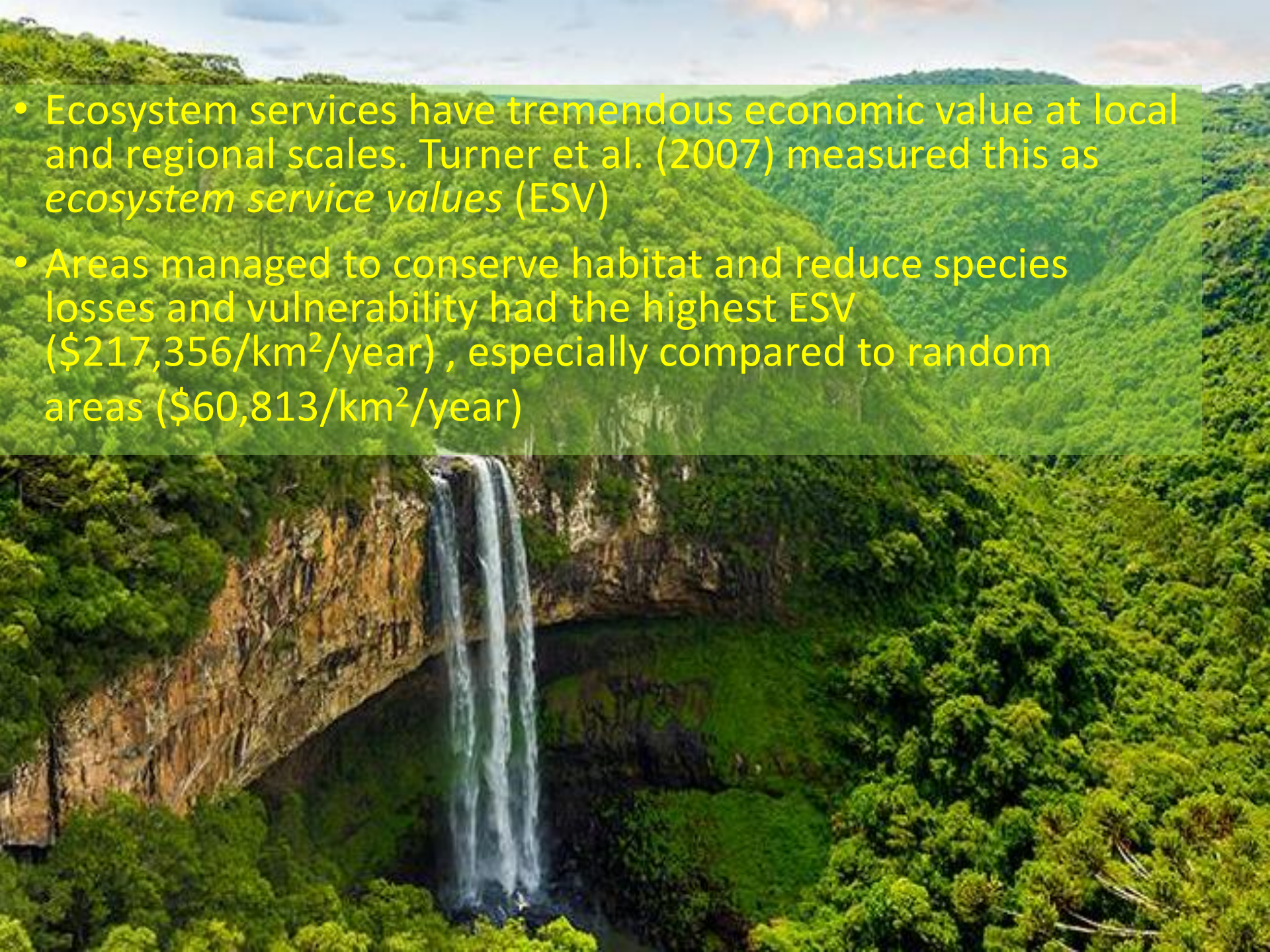
- 1/6 of the population, much living in poverty (World Bank 2006) depends on natural capital and ecosystem services from fully functioning ecosystems for their livelihood and well-being.
- A billion people depend on freshwater flowing from the Himalayas. Intact ecosystems provide valuable flood protection and other services



- Ecosystem services have tremendous economic value at local and regional scales. Turner et al. (2007) measured this as *ecosystem service values* (ESV)
- Areas managed to conserve habitat and reduce species losses and vulnerability had the highest ESV ($217,356/km^2/year) , especially compared to random areas ($60,813/km^2/year)

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Lew (1997) projected that the Asian **ecotourism** sector would see growth of 10%–25% each year, and the WTO (2014) projected Asia to be the fastest growing tourist market in the world through 2030. This a sustainable , (potentially) low impact "industry"

FUELING ASIA'S ECONOMIC GROWTH: Transport Infrastructure Development

- New and upgraded roads, highways, and railways are essential for economic development and support of vital human activities

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- The proposed Asian Highway crossing 32 countries and linking Asia to Europe spans 143,000 km
- Projections for **25 million km** of new roads by 2050 in the world, 90% in developing counties including many in Asia

Challenge:
EFFECTIVE ANALYSIS OF PROJECTS AND ALTERNATIVES

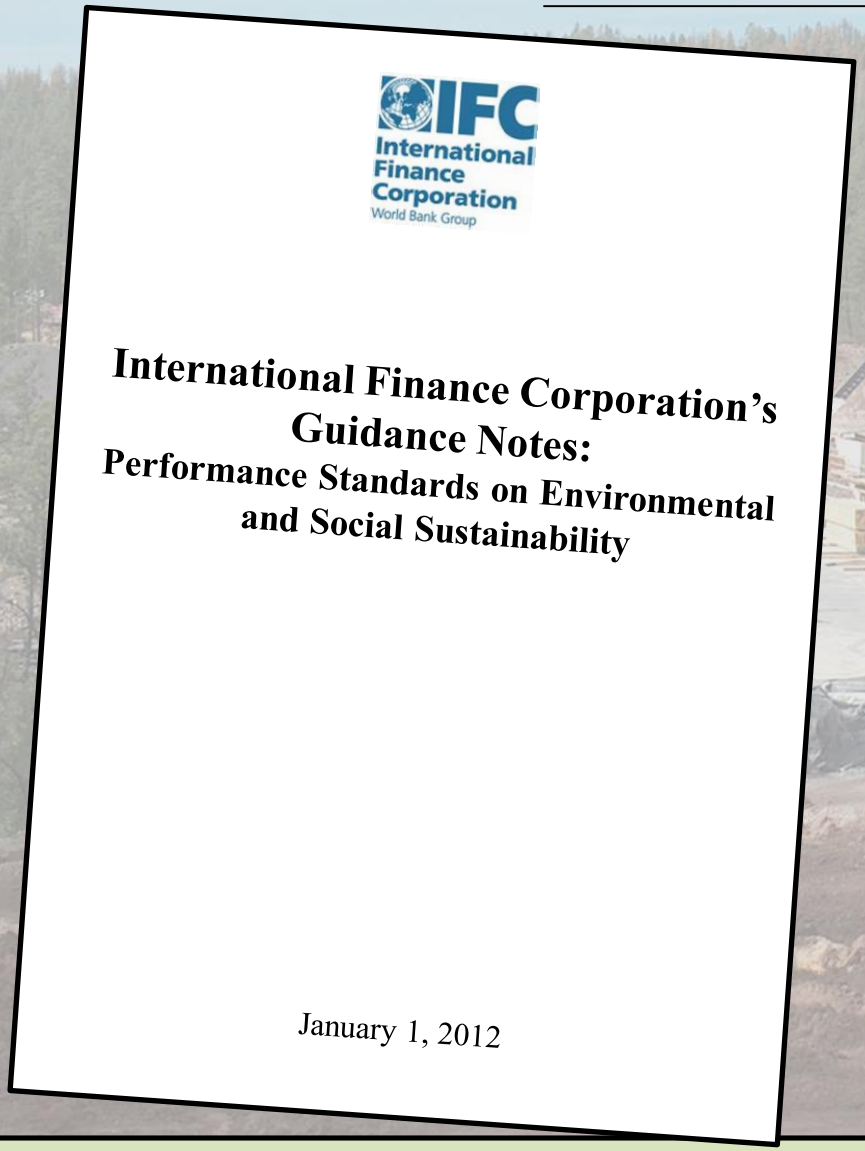
Keys to building green, sustainable transport infrastructure:

1. Systematically and consistently evaluating true environmental, economic and social issues and impact of proposed projects,

2. Pursuing alternatives without "pre-determined" outcomes, including those that avoid high-biodiversity areas where and when technically feasible and economically viable, and

3. Striving for "no-net loss" of habitat values when alternatives to impacting high-biodiversity areas do not exist and transport projects are deemed necessary

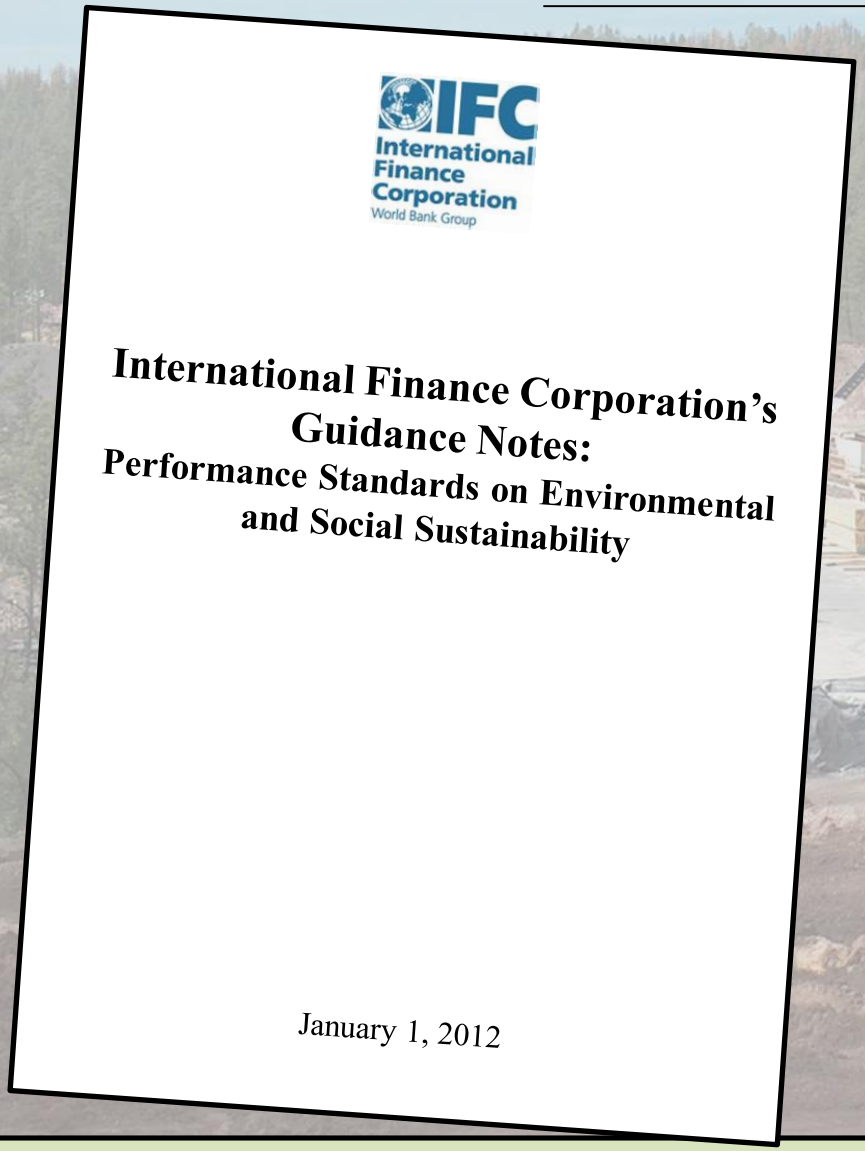
ESTABLISHING SCOPE OF PROJECT MITIGATION



IFC PERFORMANCE STANDARDS
HABITAT CLASSIFICATION

Sets respective limits for habitat degradation with projects:

ESTABLISHING SCOPE OF PROJECT MITIGATION



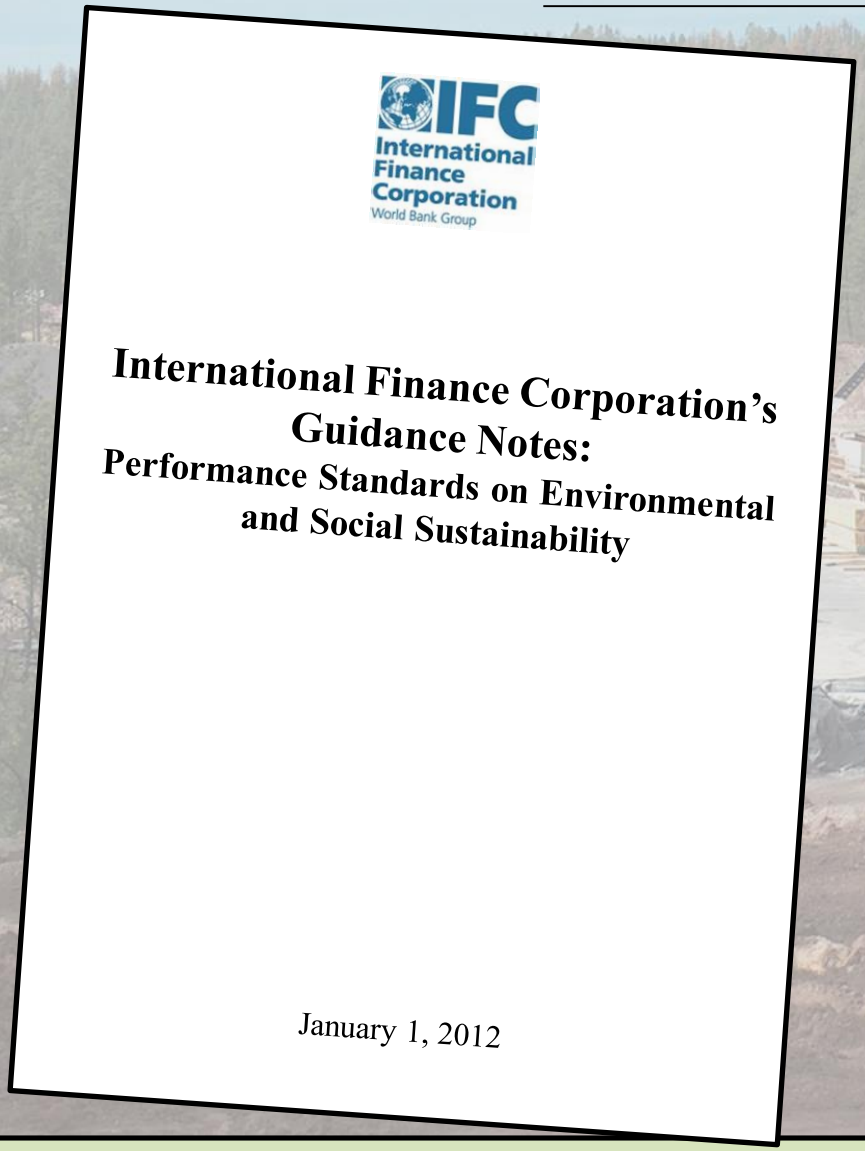
IFC PERFORMANCE STANDARDS
HABITAT CLASSIFICATION

Sets respective limits for habitat degradation with projects:

Modified habitats:

- Minimize further degradation of habitat value – mitigate impacts

ESTABLISHING SCOPE OF PROJECT MITIGATION



IFC PERFORMANCE STANDARDS *HABITAT CLASSIFICATION*

Sets respective limits for habitat degradation with projects:

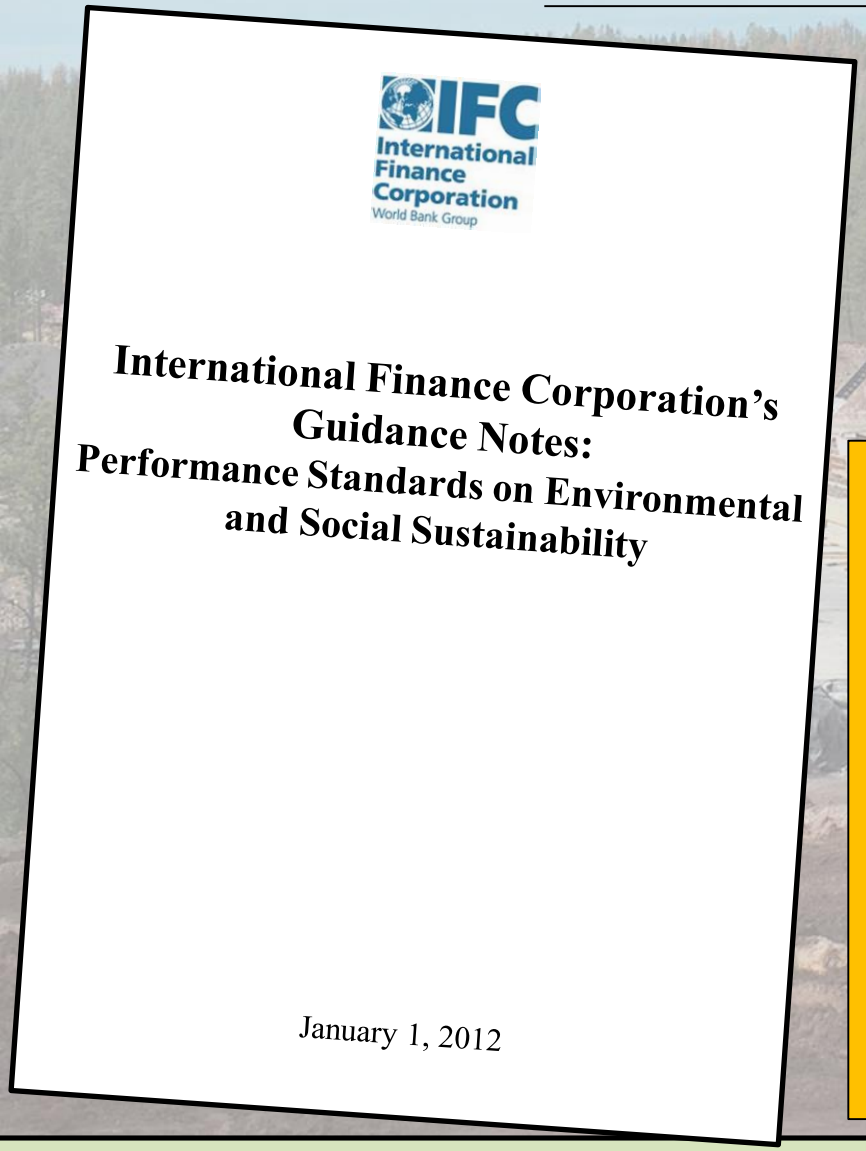
Modified habitat:

- Minimize further degradation of habitat value

Natural habitats:

- No significant habitat degradation unless **no** alternatives exist
- Benefits exceed costs (role of offsets)
- Impacts fully mitigated
- Goal is no net loss of biodiversity

ESTABLISHING SCOPE OF PROJECT MITIGATION



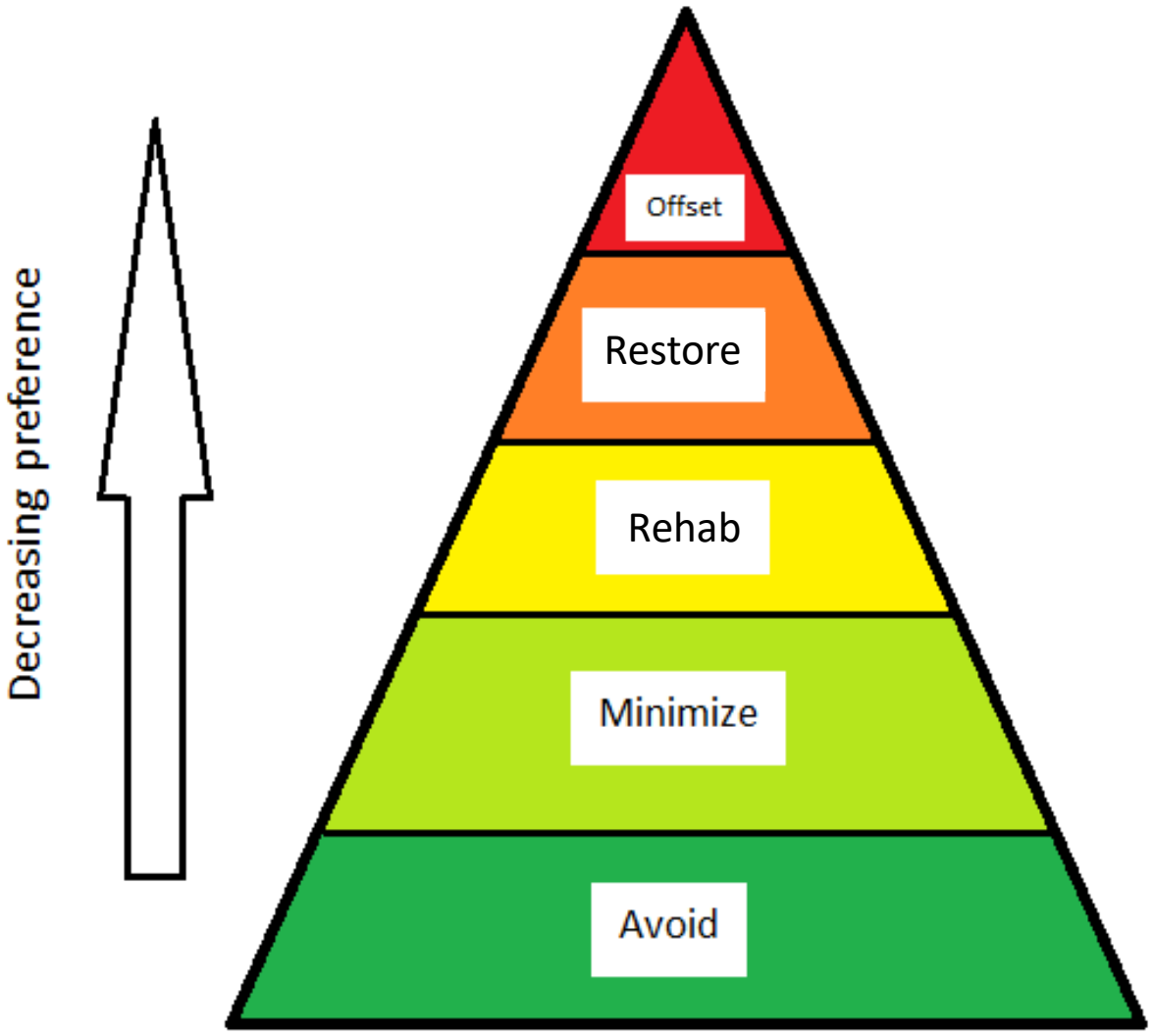
IFC PERFORMANCE STANDARDS *HABITAT CLASSIFICATIONS*

Set respective limits for habitat degradation with projects:

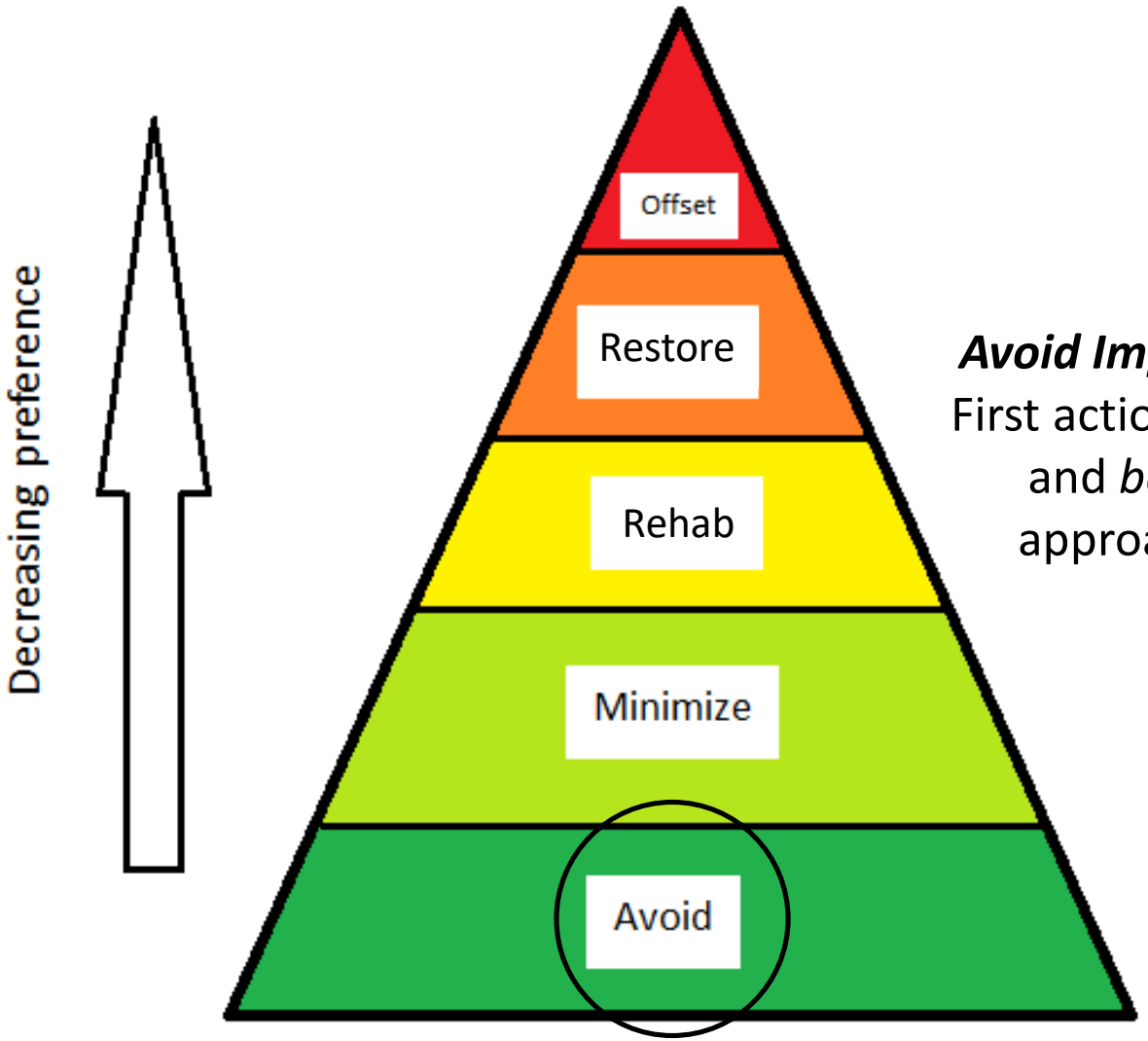
Critical habitats:

- No impairment to biodiversity and ecosystem (and ecosystem services) function
- No reduction in endangered species populations or habitat
- All lesser impacts are fully mitigated

(*IFC Performance Standard 6 Guidance Note*)

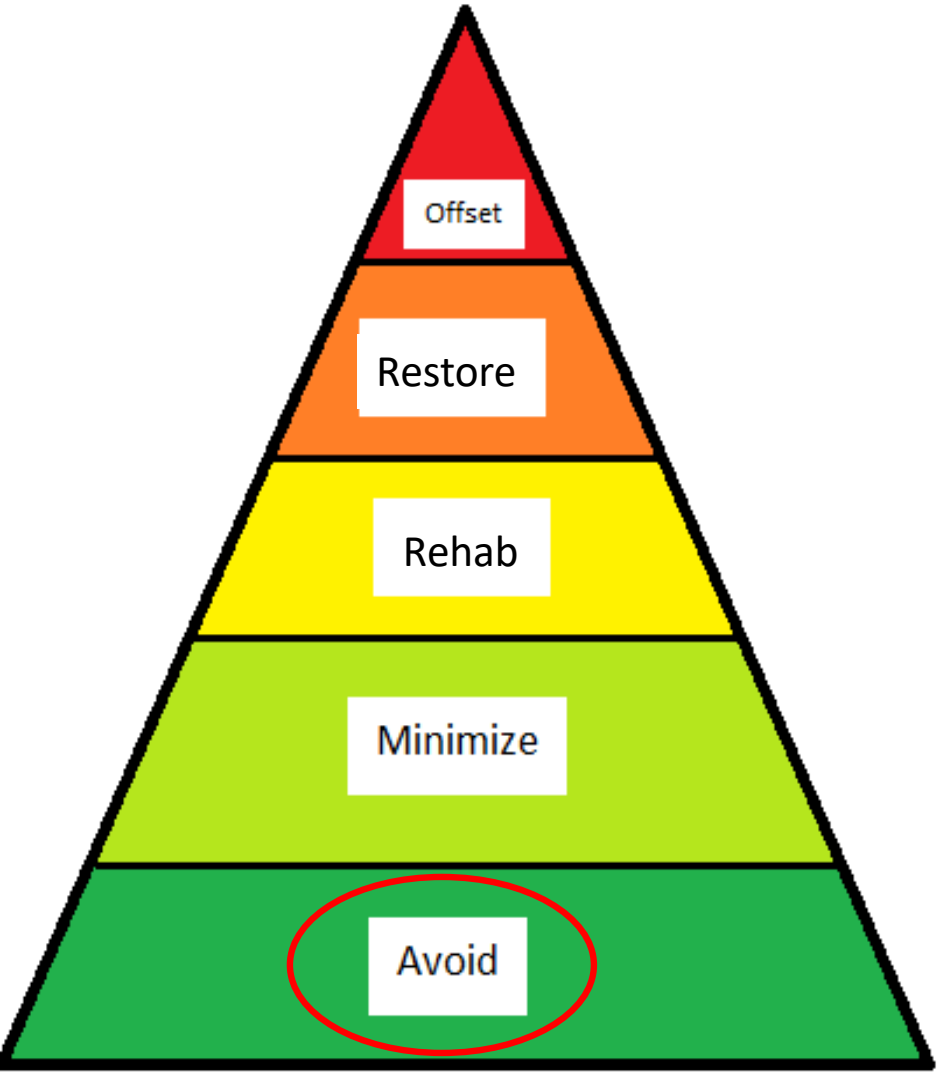


MITIGATION HIERARCHY



Avoid Impacts: First action step and *best* approach

MITIGATION HIERARCHY



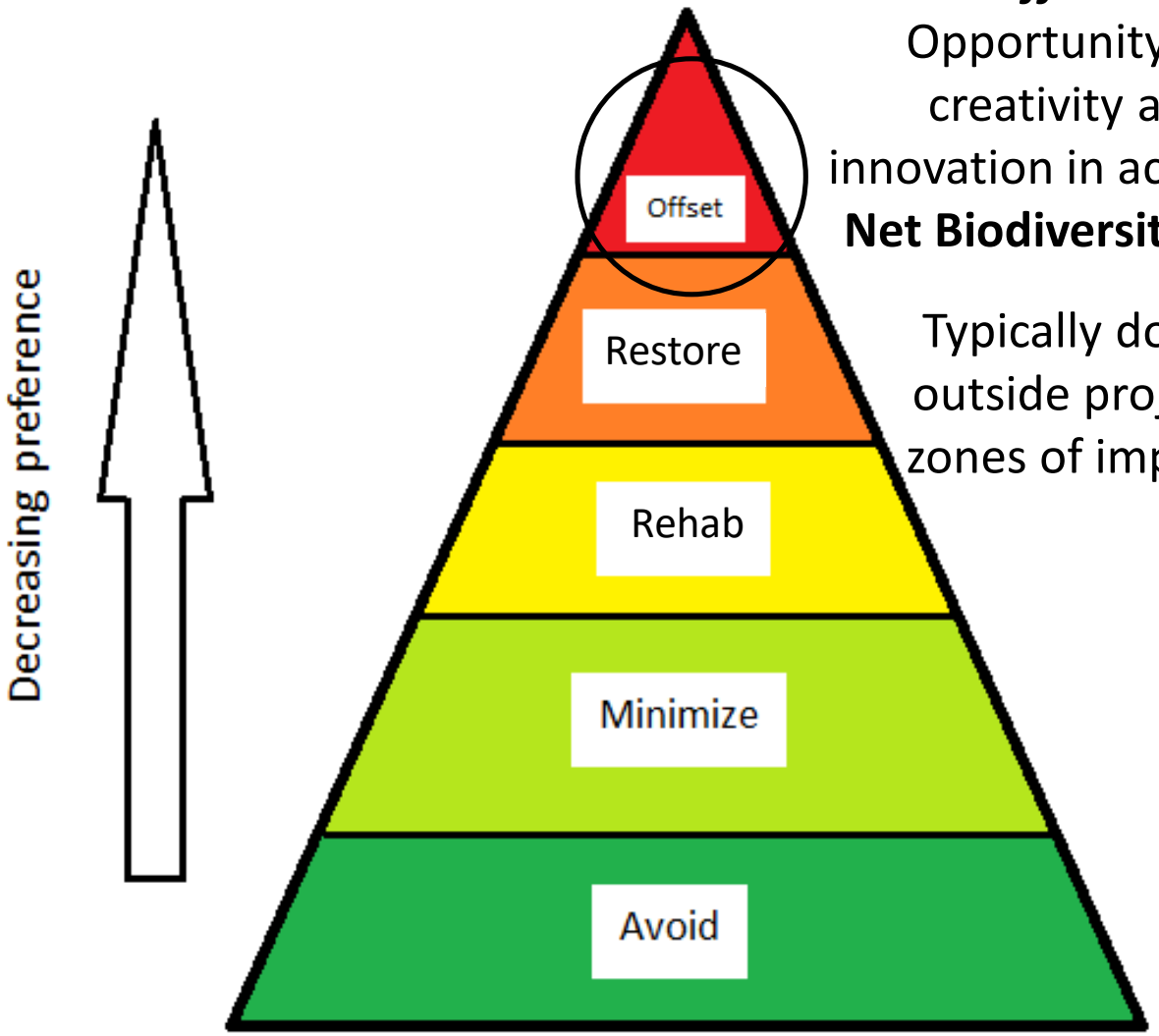
MITIGATION HIERARCHY

AVOID IMPACTS

When possible, but especially in:

- Critical habitats
- Protected areas
- High biodiversity “hotspots”
- Areas not suited for transport construction (e.g., unstable soils)

Mass slope failure - new road, Bhutan



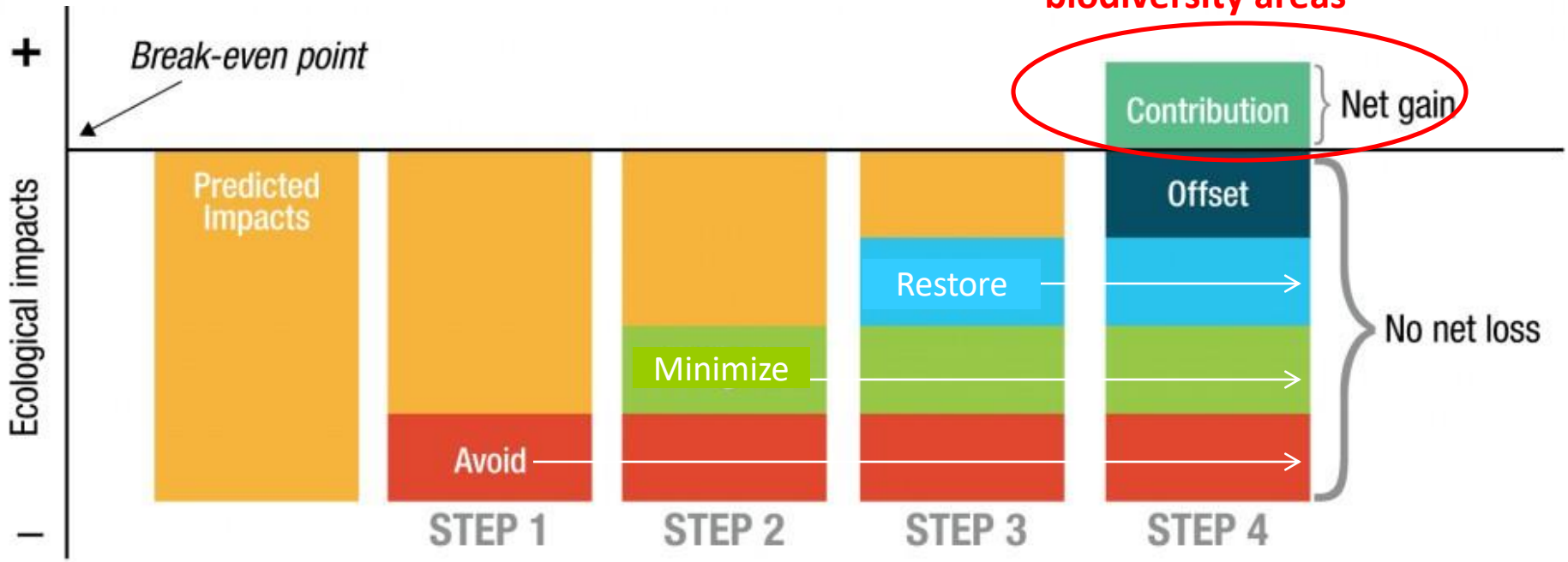
Offsets:
Opportunity for creativity and innovation in achieving **Net Biodiversity Gain**

Typically done outside project zones of impact

MITIGATION HIERARCHY

MITIGATION HIERARCHY APPLICATION

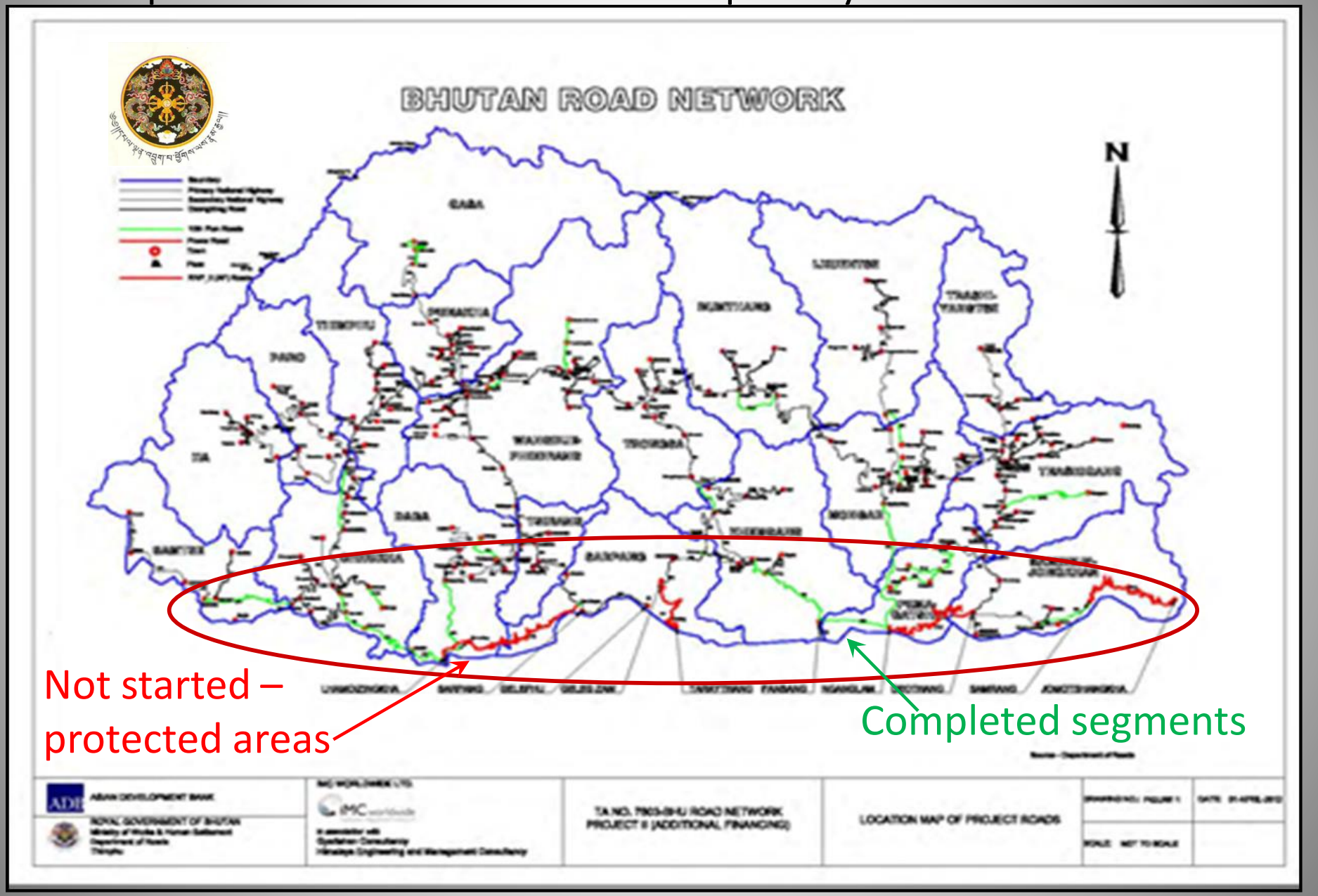
Ultimate goal in high biodiversity areas



Employ a mix of mitigation hierarchy action steps to meet a goal of **No Net Loss** of biodiversity value (and preferably to achieve a **Net Gain)**

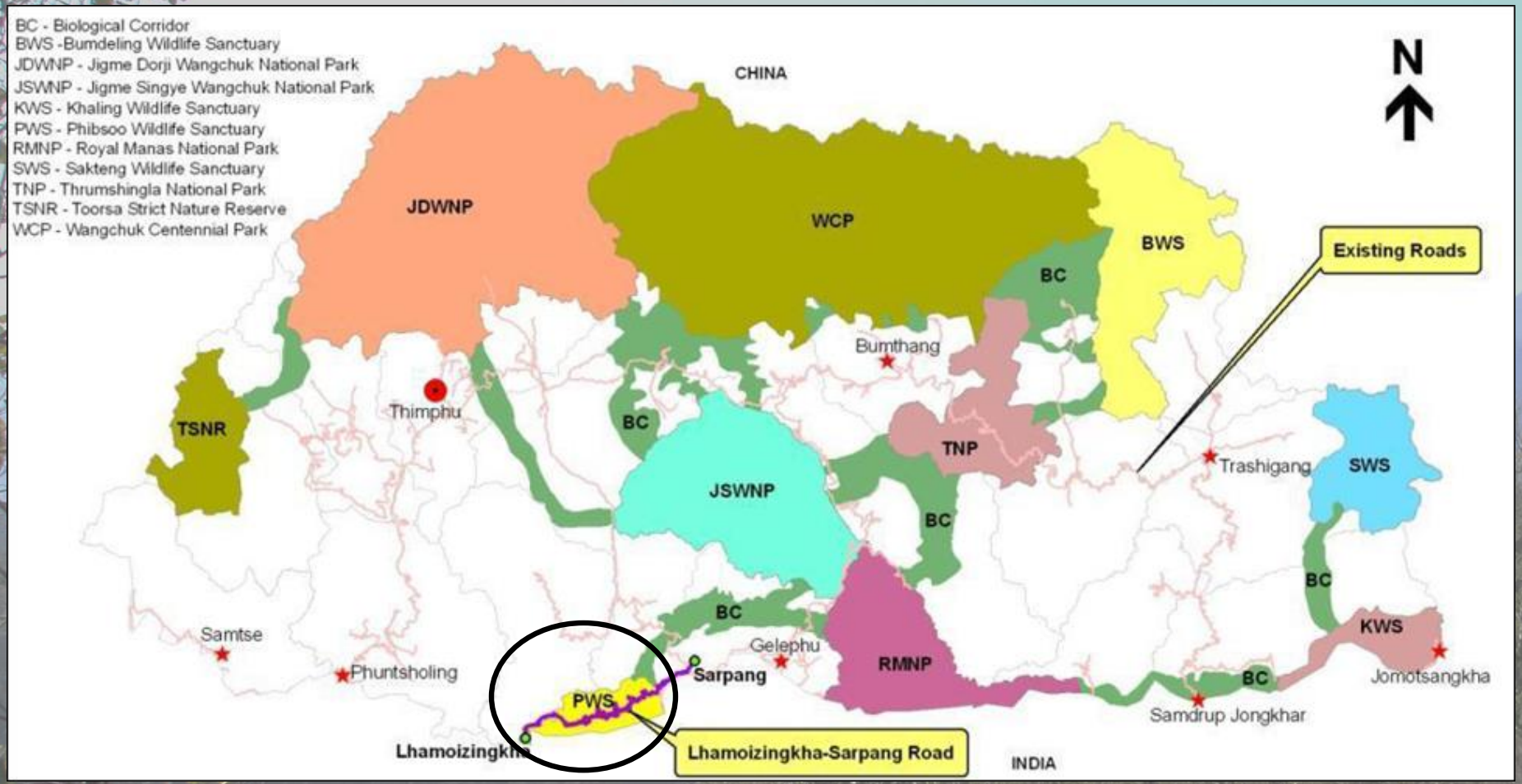
NEW SOUTHERN EAST-WEST CORRIDOR

Department of Roads Master Plan priority for 2007-2027



LHAMOIZINGKHA TO SARPANG ROAD PROJECT

Proposed to cross through Phipsoo Wildlife Sanctuary



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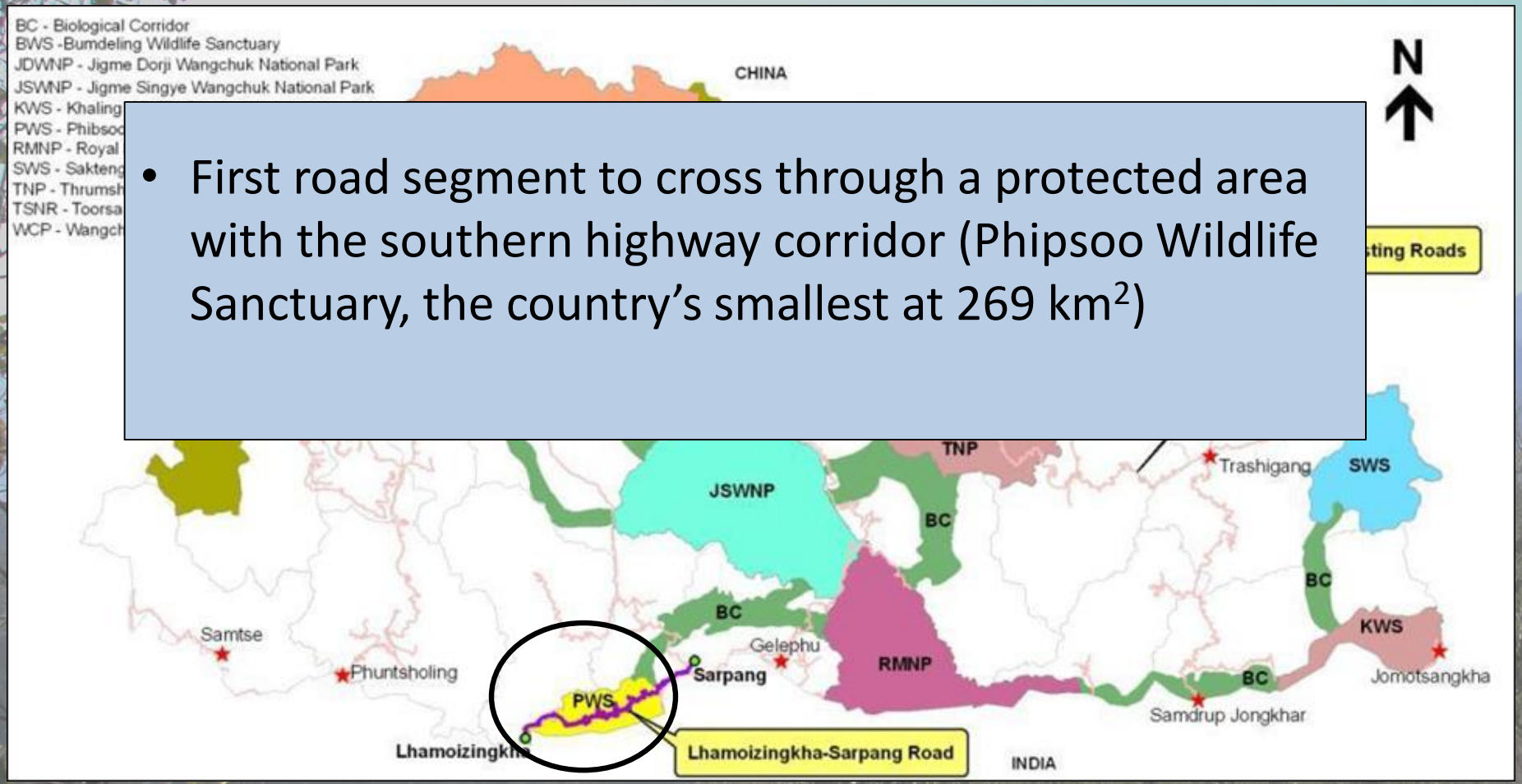


“SIGNATURE” ENDANGERED SPECIES

Phipsoo Wildlife Sanctuary

White-bellied Heron CR

Tiger EN

Asian Elephant EN

Golden Langur EN

CONFIRMED IUCN* RED LISTED SPECIES

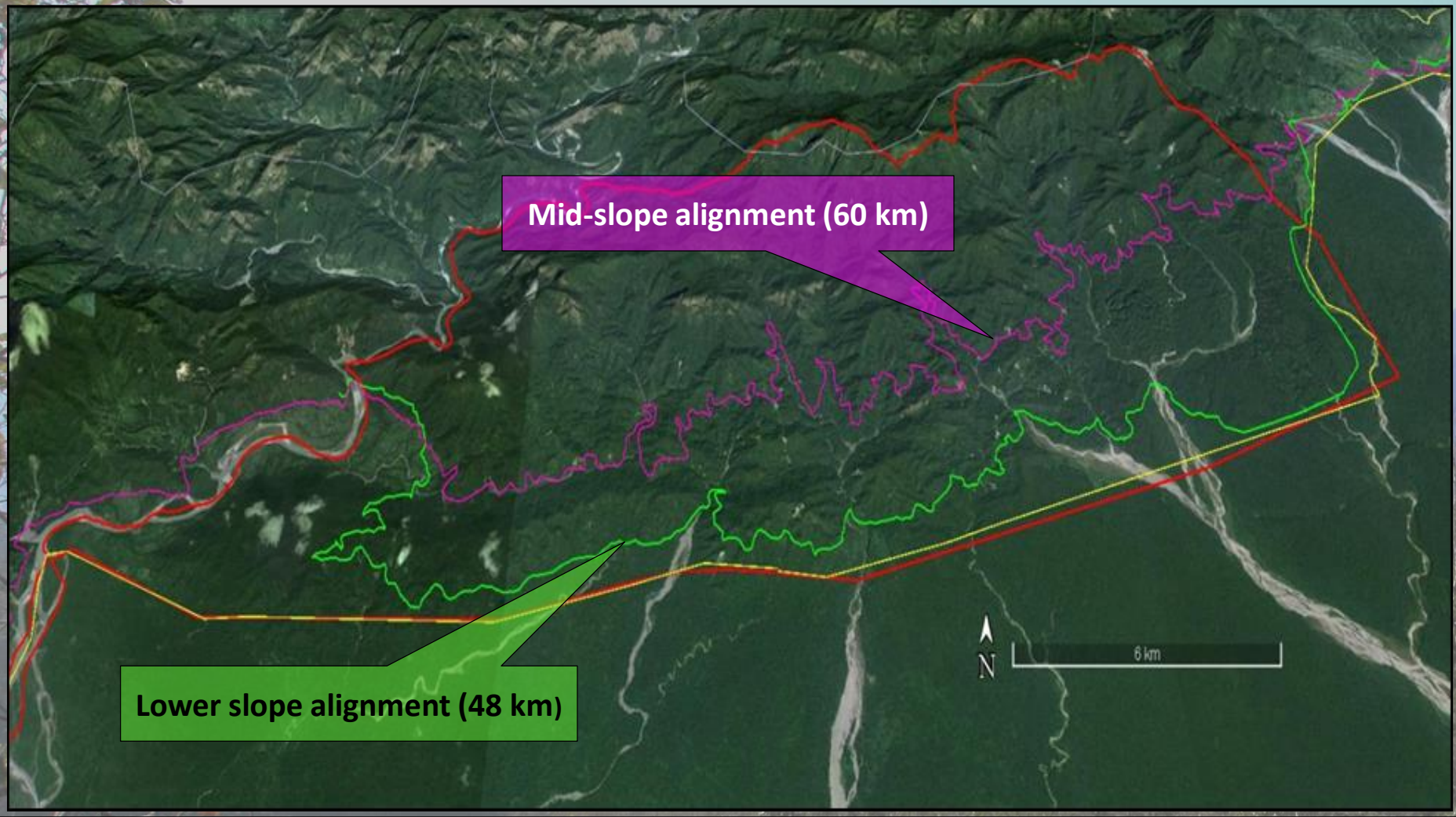
Phipsoo Wildlife Sanctuary (2015)

TAXA	SPECIES BY RED LIST STATUS				TOTAL
	Critically Endangered (CR)	Endangered (EN)	Vulnerable (VU)	Near Threatened (NT)	
Mammals	1	6	5	6	20
Birds	1	0	1	0	2
Fish	0	1	1	2	4
Reptiles	0	0	2	0	2
Plants	0	1	0	0	3
All	2	8	9	8	27

*International Union for the Conservation of Nature

LHAMOIZINGKHA TO SARPANG ROAD PROJECT

Original Proposed Alignments (2)



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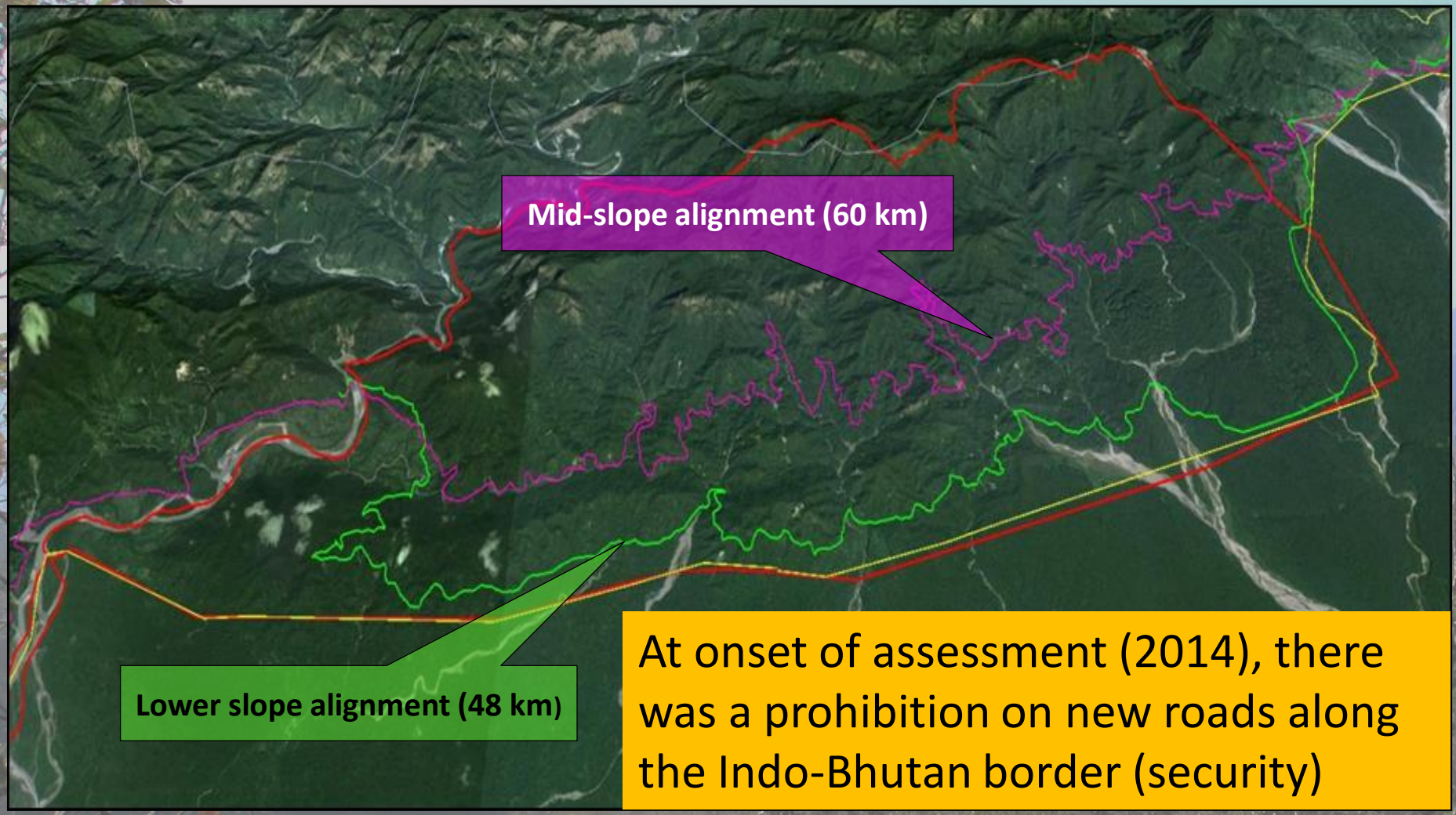
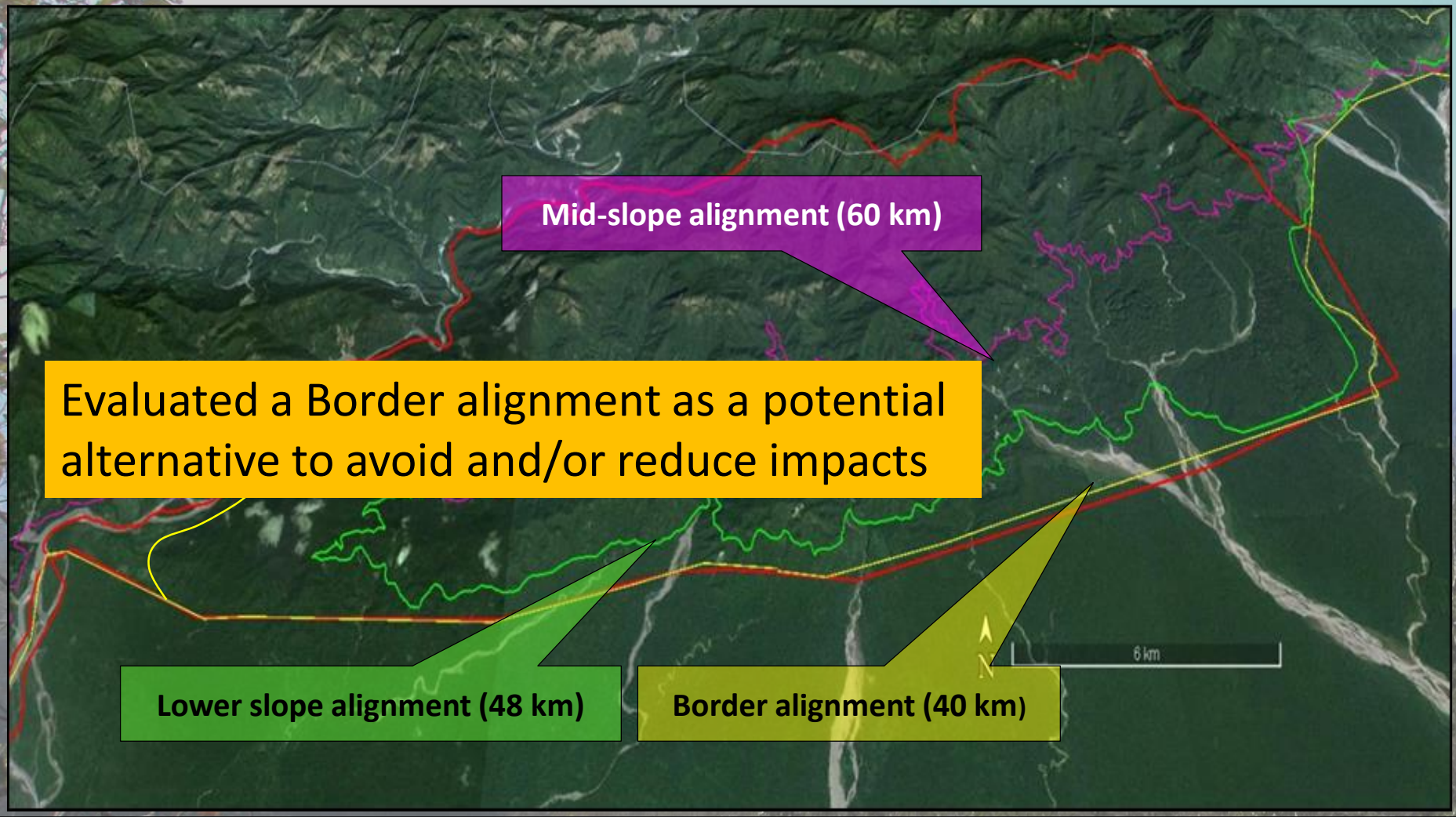


At onset of assessment (2014), there was a prohibition on new roads along the Indo-Bhutan border (security)

LHAMOIZINGKHA TO SARPANG ROAD PROJECT

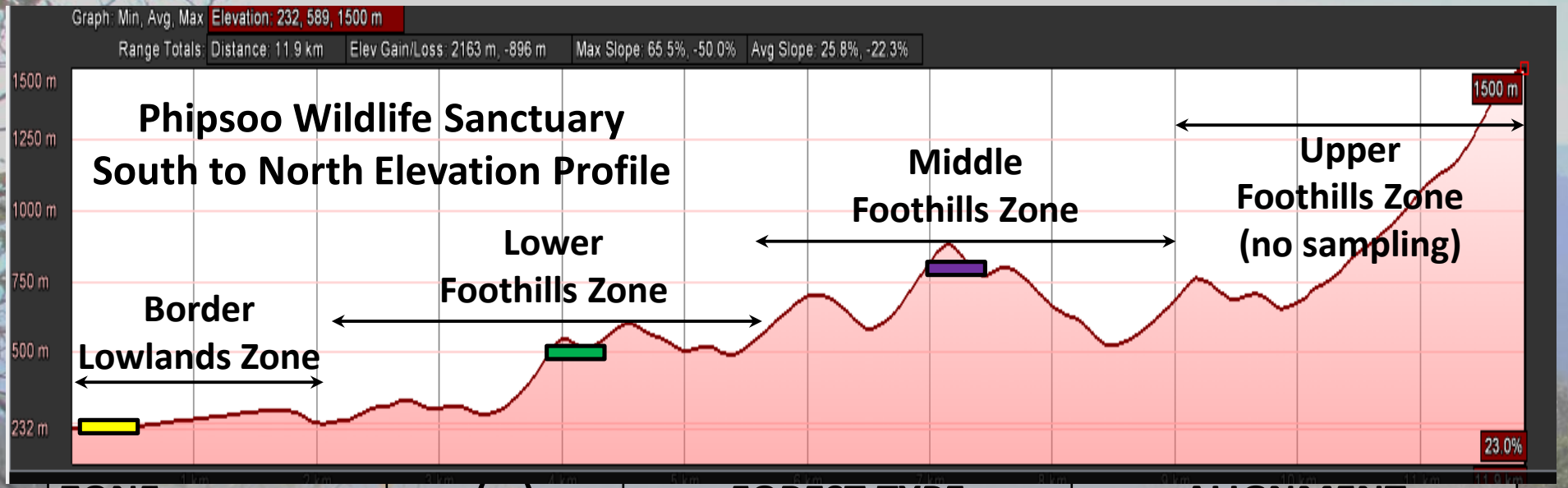
Original Proposed Alignments (2) and Alternative



BIODIVERSITY BASELINE ASSESSMENT

- Establish a biological baseline
- IFC Performance Standards compliance:
  - Classification of habitats
    - ✓ Modified
    - ✓ Natural
    - ✓ Critical
  - Critical Habitats - no loss or degradation
  - Road project "GO – NO GO" determination dependent on if the project was *biologically* feasible
- Evaluate and compare road alignment impacts

ASSESSMENT APPROACH



ZONE	(m)	FOREST TYPE	ALIGNMENT
Border Lowlands	200–300	Semi-evergreen forest	**Border alignment**
Lower Foothills	300–700	Moist deciduous forest	**Lower slope alignment**
Middle Foothills	700–1,100	Evergreen forest	**Mid-slope alignment**

BIODIVERSITY BASELINE ASSESSMENT

MAMMALIAN SPECIES INVENTORY

- Installed 45 cameras – Dec. 2014 & Jan. 2015
  - Data recovered from 38 cameras
  - Recovered May 2015 (5.5 months)

- **Highly significant biodiversity metric differences among Assessment Zones (ANOVA)**

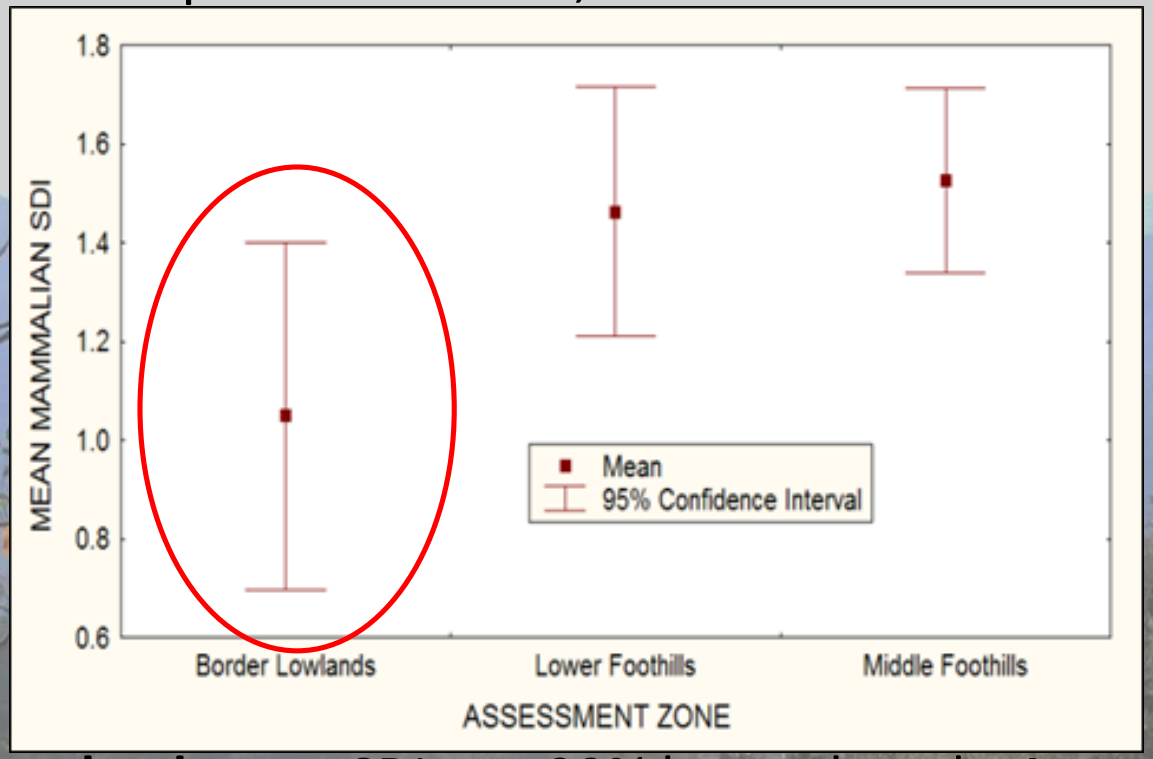
- **17,857** total images (91% mammals)
- **4,300** individual animals
- **28** mammal species (**15** species IUCN listed)

BIODIVERSITY BASELINE ASSESSMENT

MAMMALIAN SPECIES INVENTORY

Shannon-Weaver Diversity Index (SDI)

(combines species richness, abundance and evenness)



- **Border Lowlands** zone SDI was 29% lower than the **Lower Foothills** mean and 32% lower than the **Middle Foothills** mean

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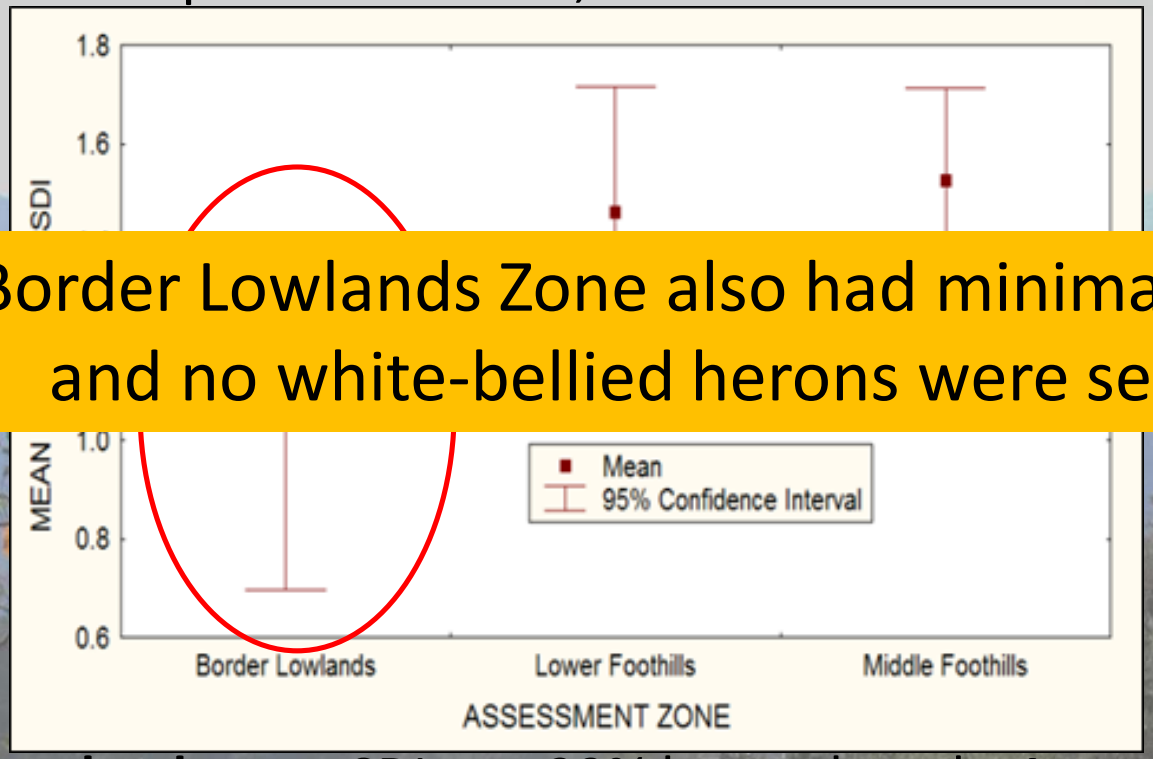

Border Lowlands Zone also had minimal tiger use and no white-bellied herons were seen here

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BIODIVERSITY BASELINE ASSESSMENT

BIODIVERSITY SUMMARY

BIODIVERSITY METRIC (values scaled to 1.0 per metric)	**ASSESSMENT ZONE**		
	BORDER LOWLANDS	**LOWER FOOTHILLS**	**MIDDLE FOOTHILLS**
Mean overstory tree SDI/site	0.39	0.32	0.36
No. of orchid species/zone	0.30	0.30	0.39
Mean avian SDI/site	0.32	0.36	0.32
Mean mammal SDI/site	0.26	0.34	0.36
Mean proportion of total mammals/site	0.16	0.33	0.51
No. of white-bellied heron observations	0.00	1.00	0.00
No. of golden langur group observations	0.06	0.44	0.51
No. of hornbill group observations	0.35	0.42	0.23
No. of khar formation locations	0.15	0.46	0.39
No. of tiger camera trapping records	0.03	0.27	0.70
Biodiversity Index (average of 10 metrics)	**0.20**	**0.42**	**0.38**

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The Biodiversity Index (based on all 10 metrics) for the Border Lowlands Zone was **half** that of the Lower and Middle Foothills zones comprising PWS's biodiversity "core"

CLASSIFICATION OF HABITATS
FOREST PLANTATION INVENTORY

- Harvested/replanted during 1950s & 1960s
- Human-modified habitat – reduced diversity (½)
- Most within **Border Lowlands** Assessment Zone


Teak plantation

- Blocks total 1,206 ha (**4.5%** of Phipsoo's area)
- Approx. 50 plantation plots within blocks

BIODIVERSITY BASELINE ASSESSMENT
SPECIAL HABITAT INVENTORY & ASSESSMENT

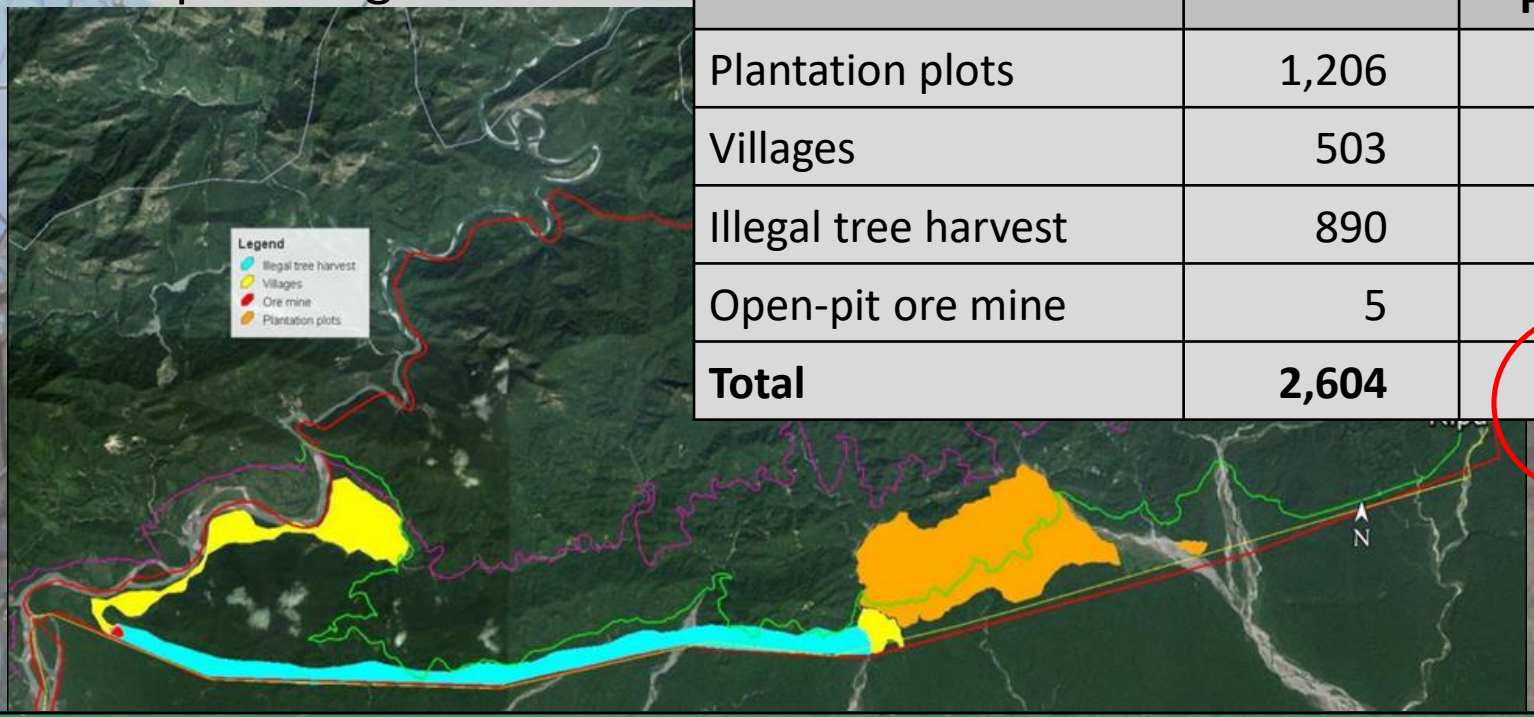
ILLEGAL TREE HARVEST

- Illegal tree harvest long a concern – poorly quantified in past
- Occurs along the Indo-Bhutan border in an approximately 15 km-long band
- In places, poaching so heavy that the few remaining trees have fallen over
- Cutting moving up slopes since accessible trees liquidated
- All poaching occurs in the **Border Lowlands Zone**

BIODIVERSITY BASELINE ASSESSMENT
CLASSIFICATION OF HABITATS
MODIFIED HABITAT

- Human-influenced **Modified Habitats** – most in **Border Lowlands Zone**
  - Villages (Nichula, Pingkhua)
  - Plantations
  - Tree poaching

HUMAN ACTIVITY	AREA (HA)	PERCENT OF PHIPSOO
Plantation plots	1,206	4.5%
Villages	503	1.9%
Illegal tree harvest	890	3.3%
Open-pit ore mine	5	<0.1%
Total	**2,604**	**9.7%**

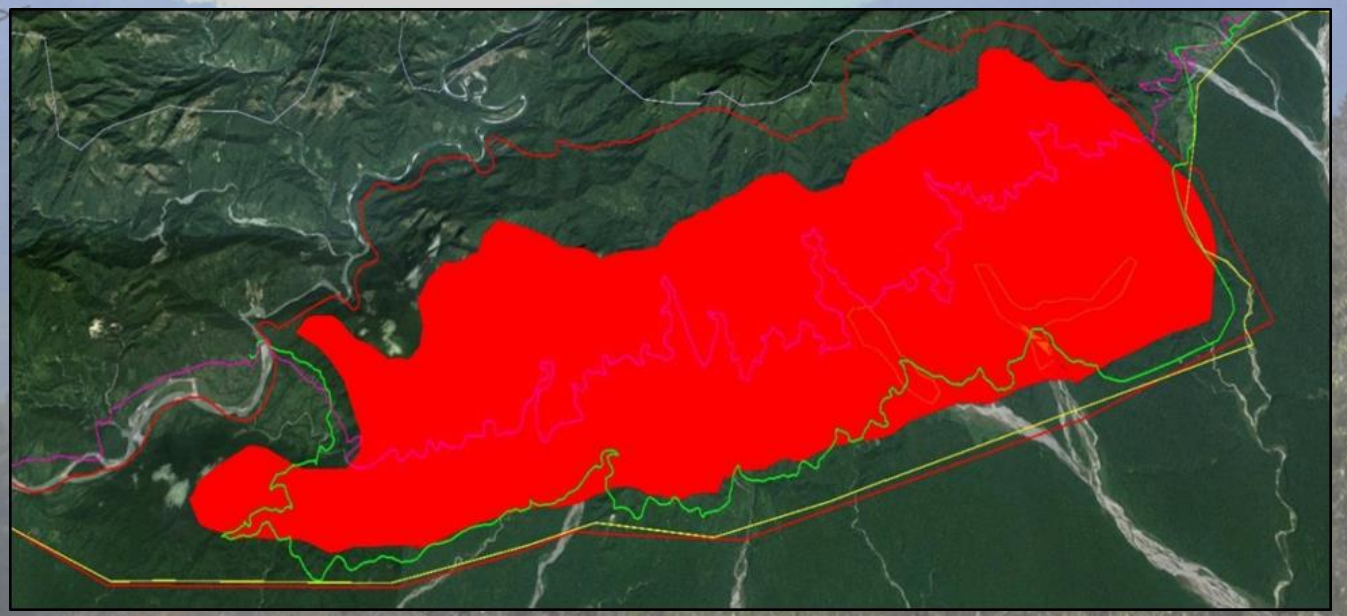


BIODIVERSITY BASELINE ASSESSMENT
CLASSIFICATION OF HABITATS
WHITE-BELLIED HERON CRITICAL HABITAT

- Critically endangered species
- Critical Habitat along Longa & Phipsoo rivers (3%)
- Biggest threat is the indiscriminate poisoning of fish by poachers that take fish to market

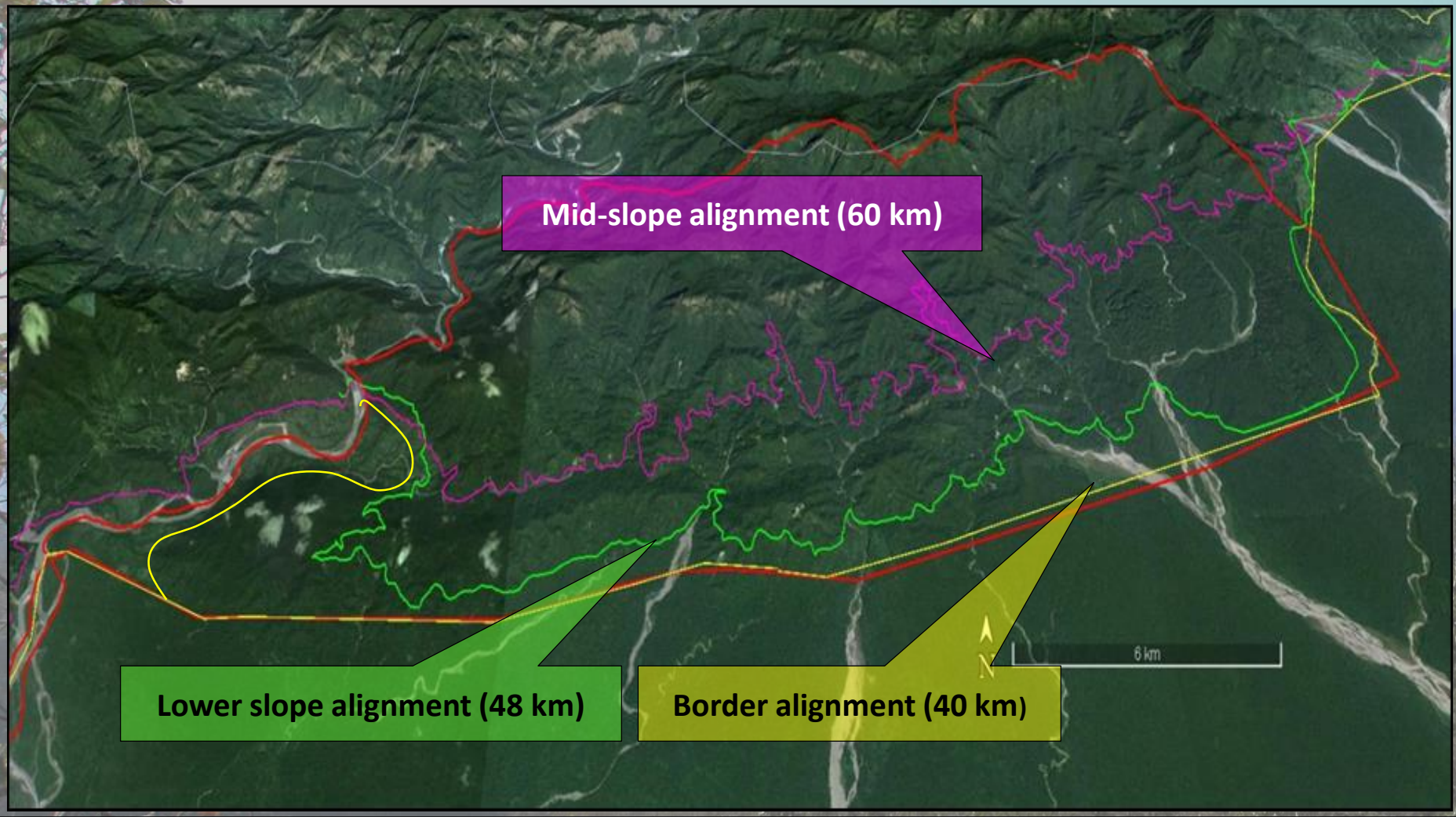
BIODIVERSITY BASELINE ASSESSMENT
CLASSIFICATION OF HABITATS
TIGER CRITICAL HABITAT

- Tiger Critical Habitat encompasses Phipsoo "core" in the **Lower and Middle Foothills zones**
  - Just 1 tiger recorded in **Border Lowlands Zone**
  - 16,000 ha (60%)
- "Umbrella" designation for other candidate species



LHAMOIZINGKHA TO SARPANG ROAD PROJECT

COMPARISON OF ALIGNMENTS



ROAD IMPACTS ASSESSMENT
DIRECT ROAD IMPACTS
LOSS OF HABITATS WITH CONSTRUCTION

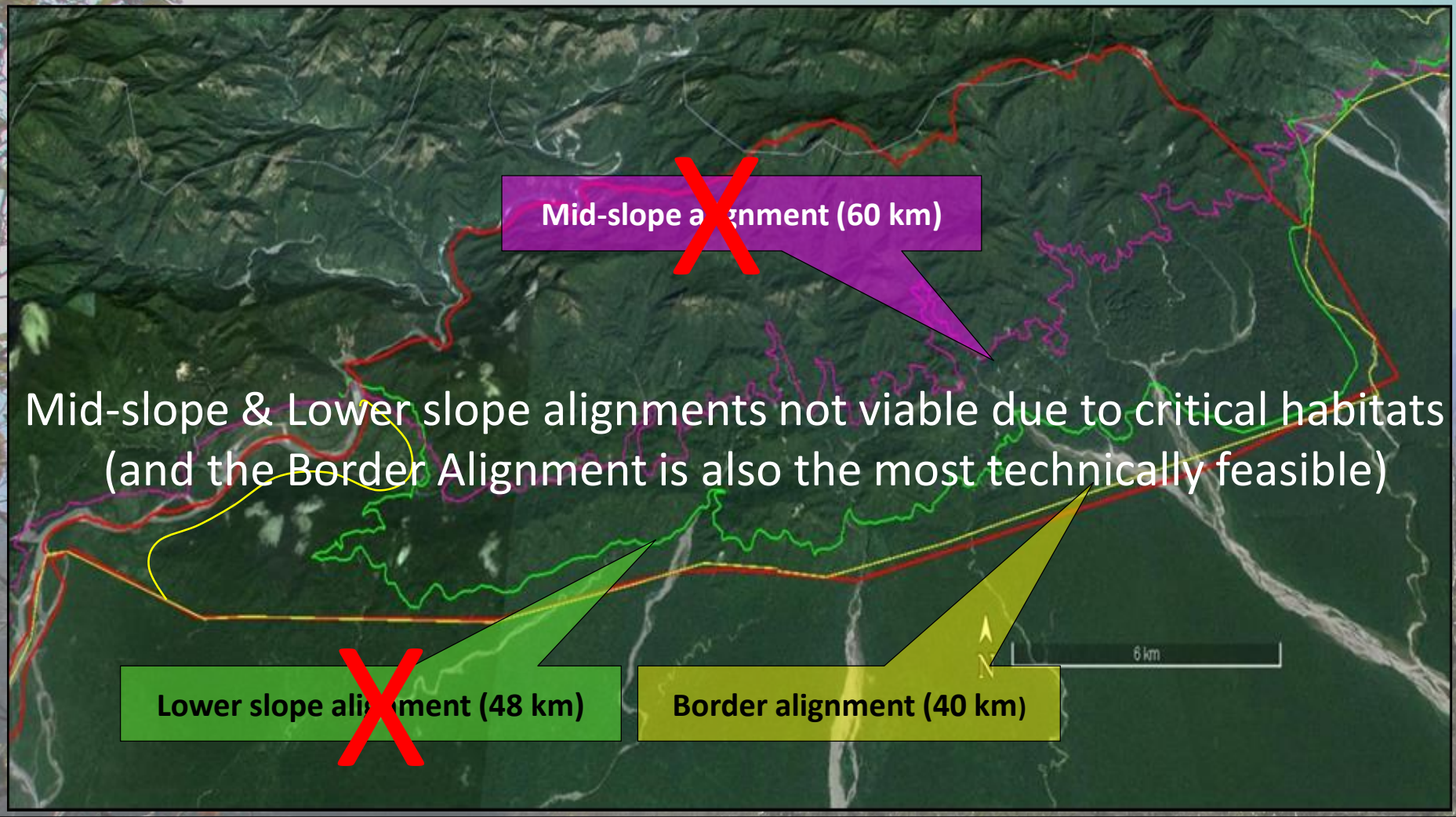
Proportion of road through Critical, Natural and Modified habitat

- IFC Performance Standard mandates **no** loss or negative impact to Critical Habitat

PROPOSED ROAD ALIGNMENT	PREDOMINATE ASSESSMENT ZONE	LSR LENGTH (KM)	HABITAT DIRECTLY IMPACTED (HA)		
			MODIFIED (%)	NATURAL (%)	CRITICAL (%)
Mid-slope	Middle Foothills	60	0 (0%)	13 (7%)	**167 (93%)**
Lower slope	Lower Foothills	48	16 (17%)	20 (21%)	**60 (62%)**
Border	Border Lowlands	40	21 (52%)	19 (48%)	**0 (0%)**

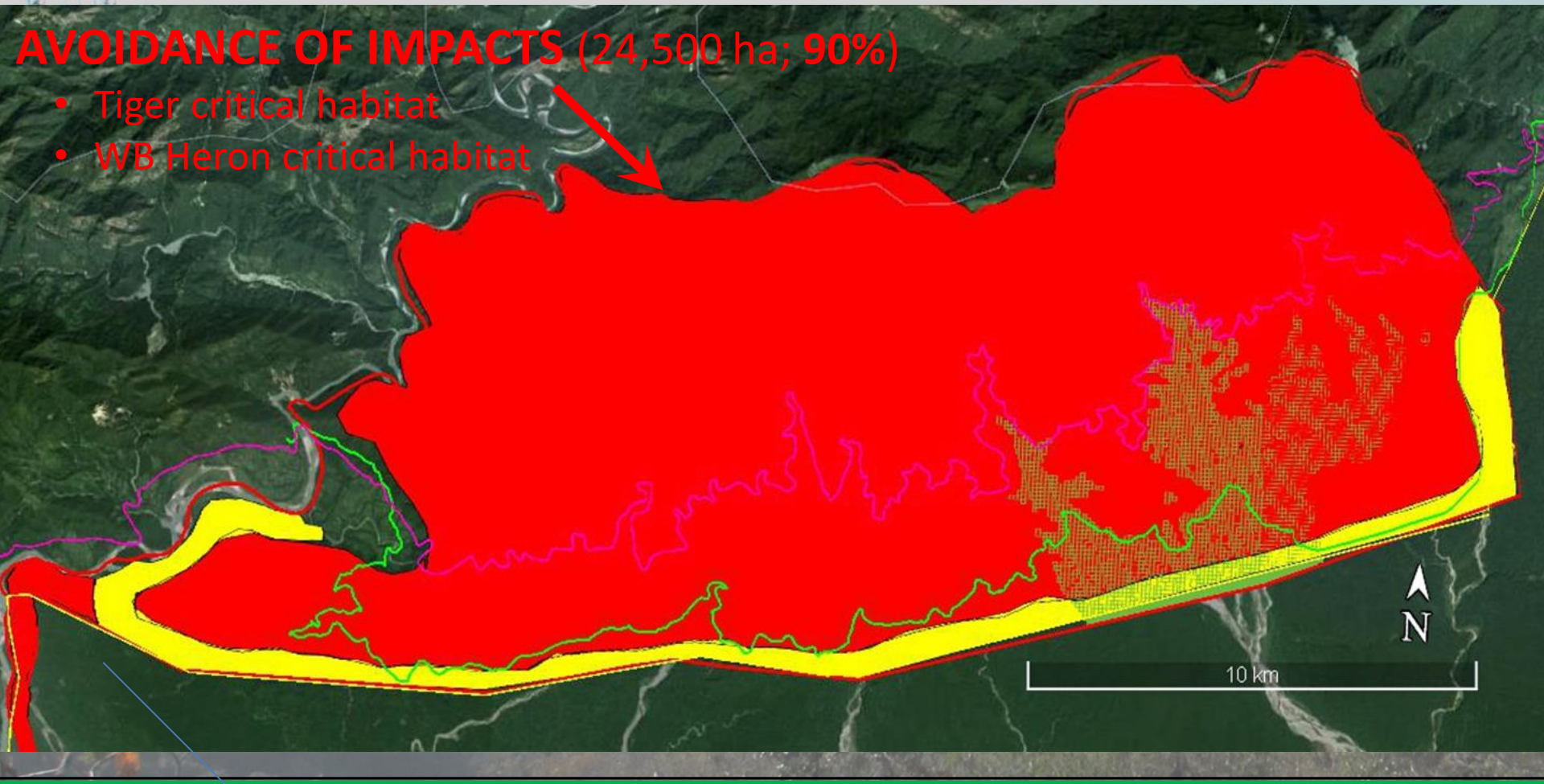
LHAMOIZINGKHA TO SARPANG ROAD PROJECT

Preferred Alignment (in Border Lowlands)



ROAD AND CONSERVATION PROJECT STRATEGY

MITIGATION HIERARCHY APPLICATION



ROAD AND CONSERVATION PROJECT STRATEGY

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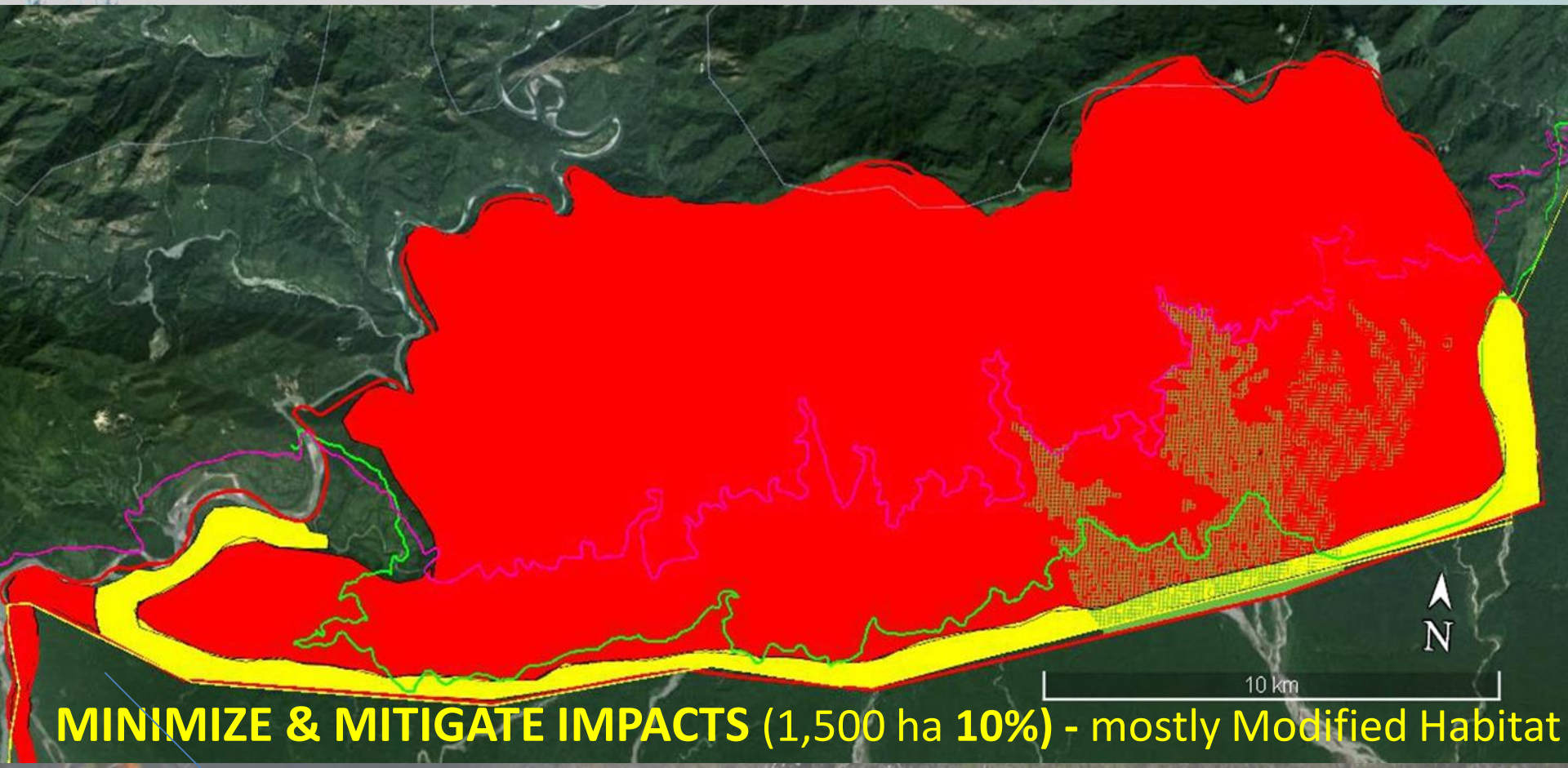


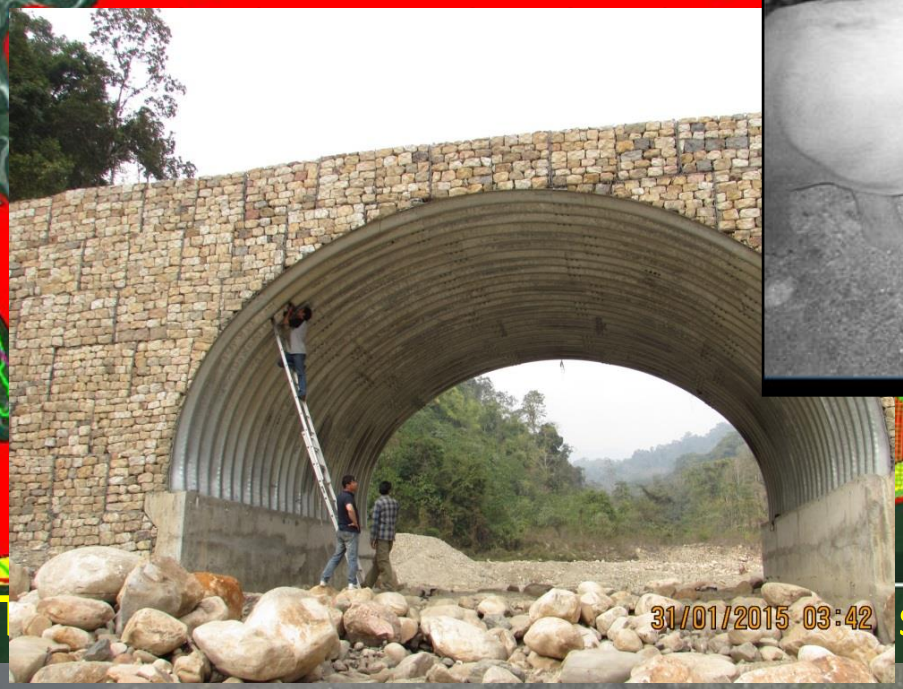
MINIMIZE & MITIGATE IMPACTS (1,500 ha **10%) -** mostly Modified Habitat

ROAD AND CONSERVATION PROJECT STRATEGY

MITIGATION HIERARCHY APPLICATION

AVOIDANCE OF IMPACTS (24,500 ha; **91%**)

- Tiger critical habitat
- WB Heron critical habitat
- Khar formations



MINIMIZE & MIT

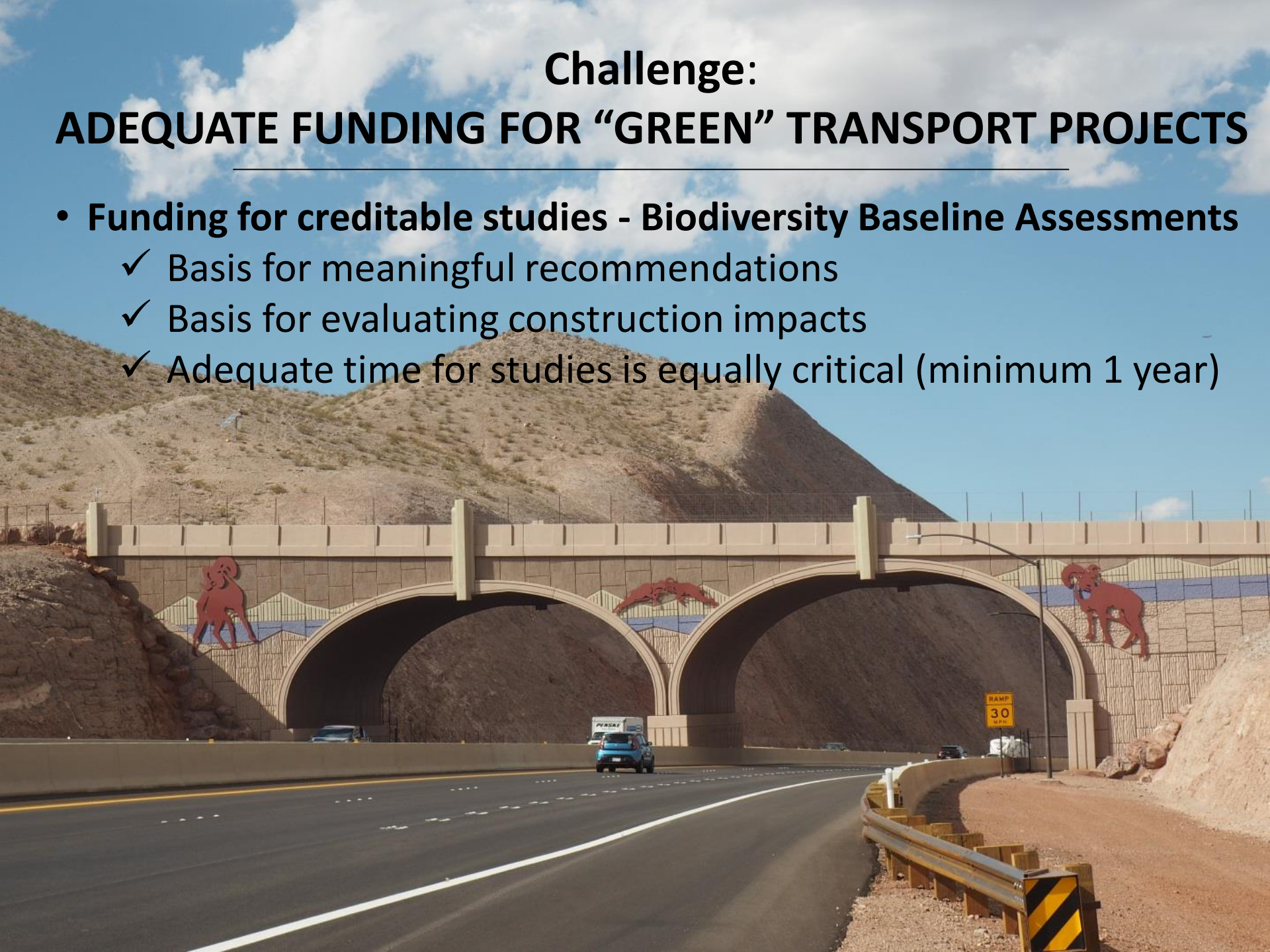
stly Modified Habitat

N

10 km

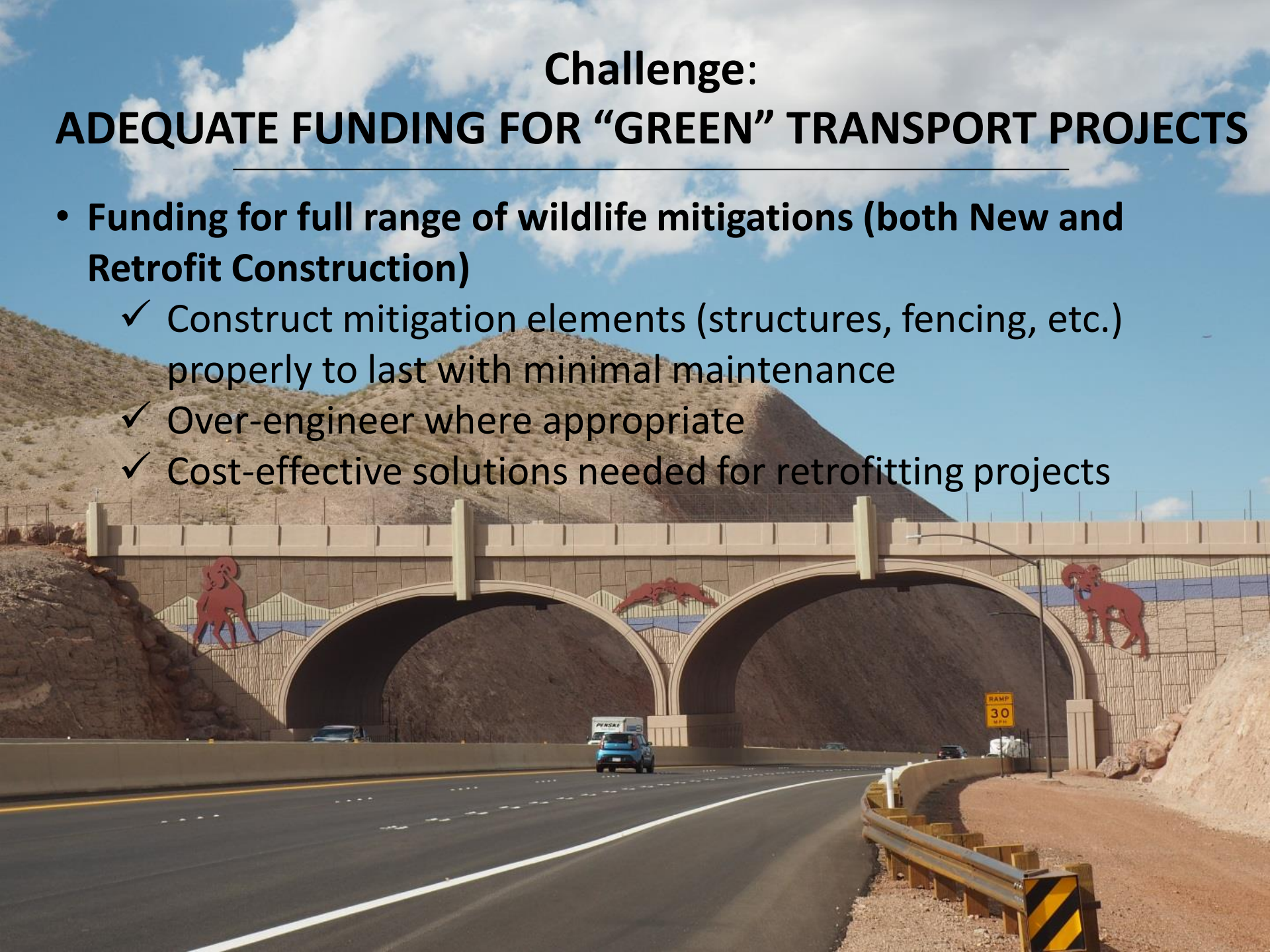
ROAD AND CONSERVATION PROJECT STRATEGY

MITIGATION HIERARCHY APPLICATION



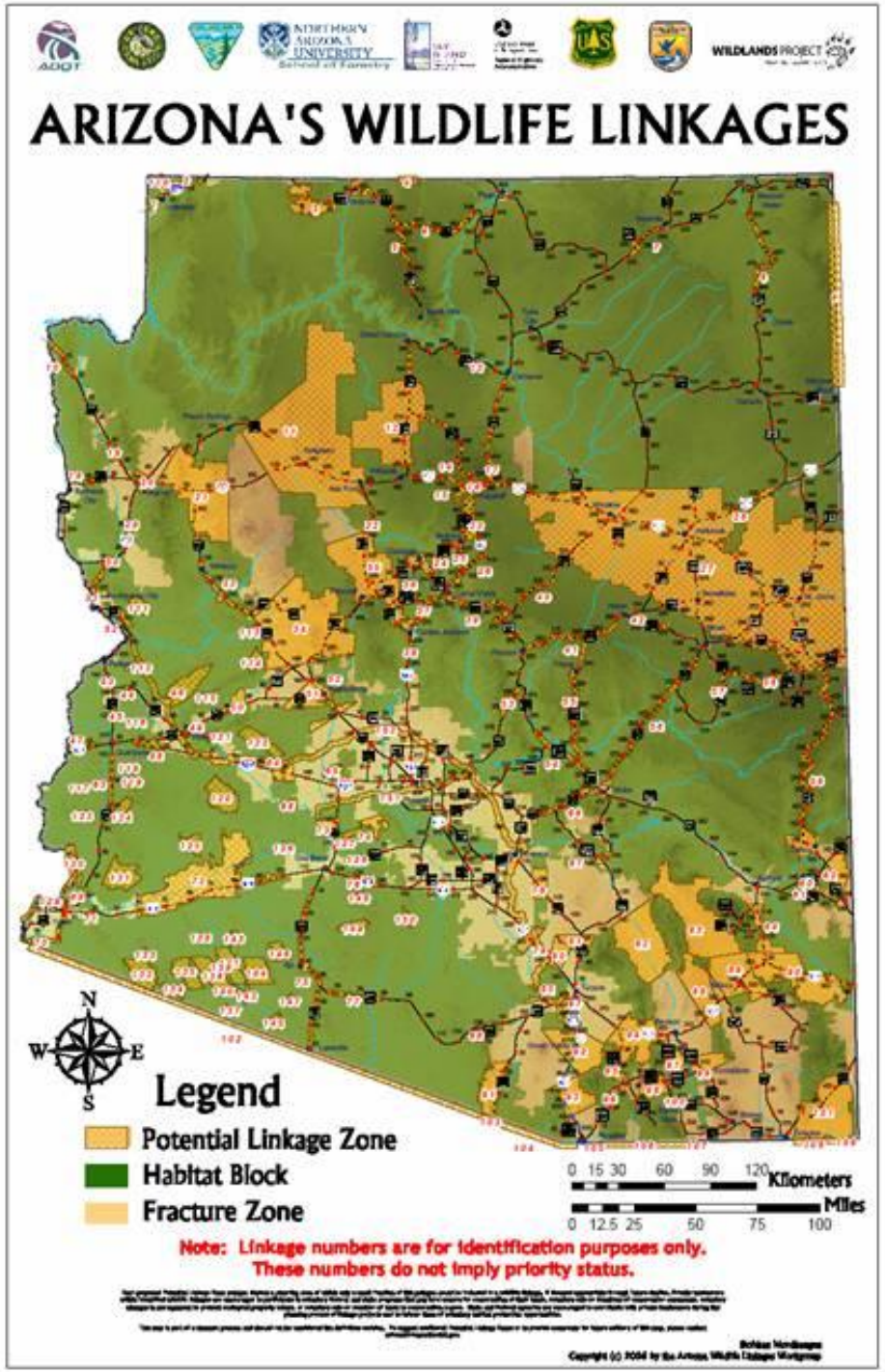
Challenge:
ADEQUATE FUNDING FOR "GREEN" TRANSPORT PROJECTS

- **Funding for creditable studies - Biodiversity Baseline Assessments**
  - ✓ Basis for meaningful recommendations
  - ✓ Basis for evaluating construction impacts
  - ✓ Adequate time for studies is equally critical (minimum 1 year)



Challenge:
ADEQUATE FUNDING FOR "GREEN" TRANSPORT PROJECTS

- **Funding for full range of wildlife mitigations (both New and Retrofit Construction)**
  - ✓ Construct mitigation elements (structures, fencing, etc.) properly to last with minimal maintenance
  - ✓ Over-engineer where appropriate
  - ✓ Cost-effective solutions needed for retrofitting projects



AVENUES TO ADDRESS WILDLIFE-HIGHWAY CONFLICTS

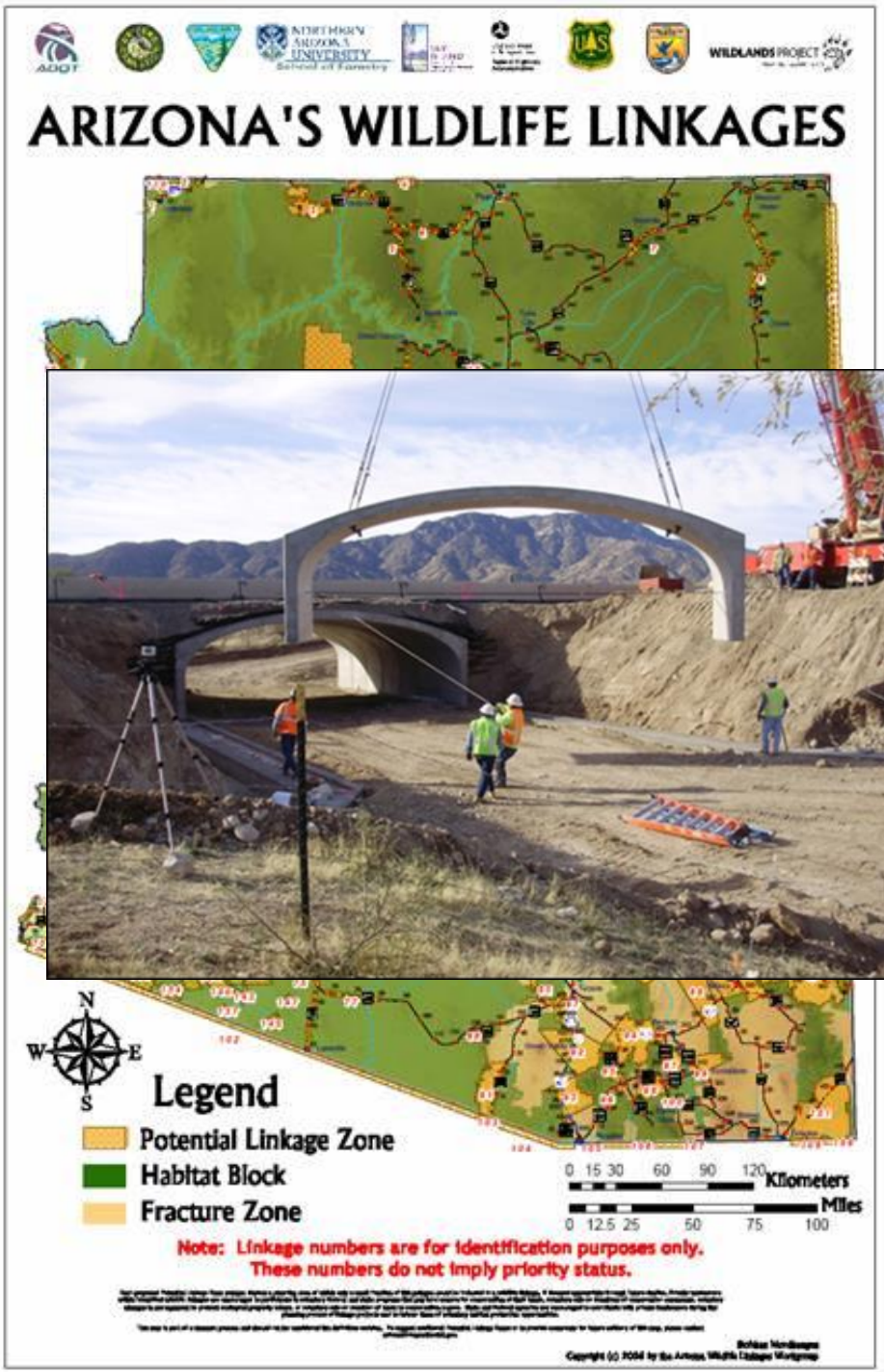
Role of Retrofitting

- Priority highway with significant safety issues **1,220 km**
- Highway reconstruction completed since 2000 **95 km (8%)**
- Highway planned for future reconstruction (20 years) **150 km (12%)**

Retrofitting is an alternative to limited new highway construction to address **existing conflicts**

AVENUES TO ADDRESS WILDLIFE-HIGHWAY CONFLICTS

Role of Retrofitting



(20 years)

Retrofitting is an alternative to limited new highway construction to address **existing conflicts**

Challenge:
ADEQUATE FUNDING FOR "GREEN" TRANSPORT PROJECTS

- **Integrating Climate Change Resiliency**
  - ✓ Oversizing drainage structures as "dual-use" wildlife passages

Challenge:
INTEGRATING CLIMATE CHANGE RESILIENCY

- **Oversizing of Drainage Culverts to Underpasses**
  - ✓ Provide cost effective "**dual-use**" structures for drainage *and* wildlife passage
  - ✓ Prevent blowouts from increasingly frequent extreme-weather events using oversized drainage structures at ***modest*** additional cost*

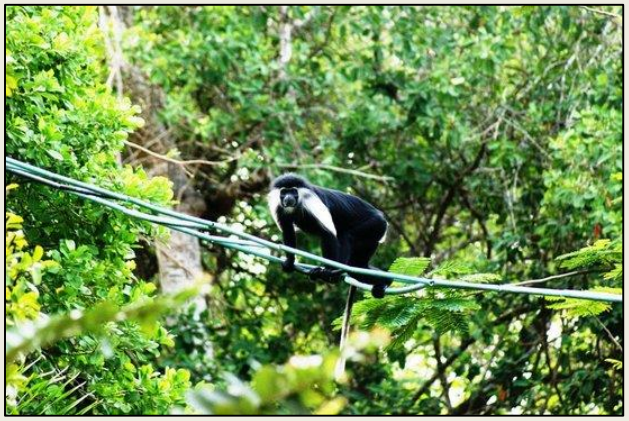
*_Intergovernmental Panel on Climate Change_ (IPCC). 2014: Climate Change 2014: Synthesis Report.

Challenge:
ADEQUATE FUNDING FOR "GREEN" TRANSPORT PROJECTS

- **Funding for construction oversight monitoring**
  - ✓ Build it properly the first (and only) time
- **Funding for post-construction effectiveness monitoring**
  - ✓ To support Adaptive Management

Challenge:
INTEGRATING MITIGATION STRATEGIES

- A diverse "*Toolbox*" of measures is available to address wildlife-vehicle/train collision and wildlife connectivity issues with context-sensitive solutions
- Effective strategies often employ a *mix of measures* (e.g., signage and traffic calming treatments, passage structures, funnel fencing)
- All the measures used in a strategy must function as an *integrated unit or system* – failure of one element can render the entire system ineffective

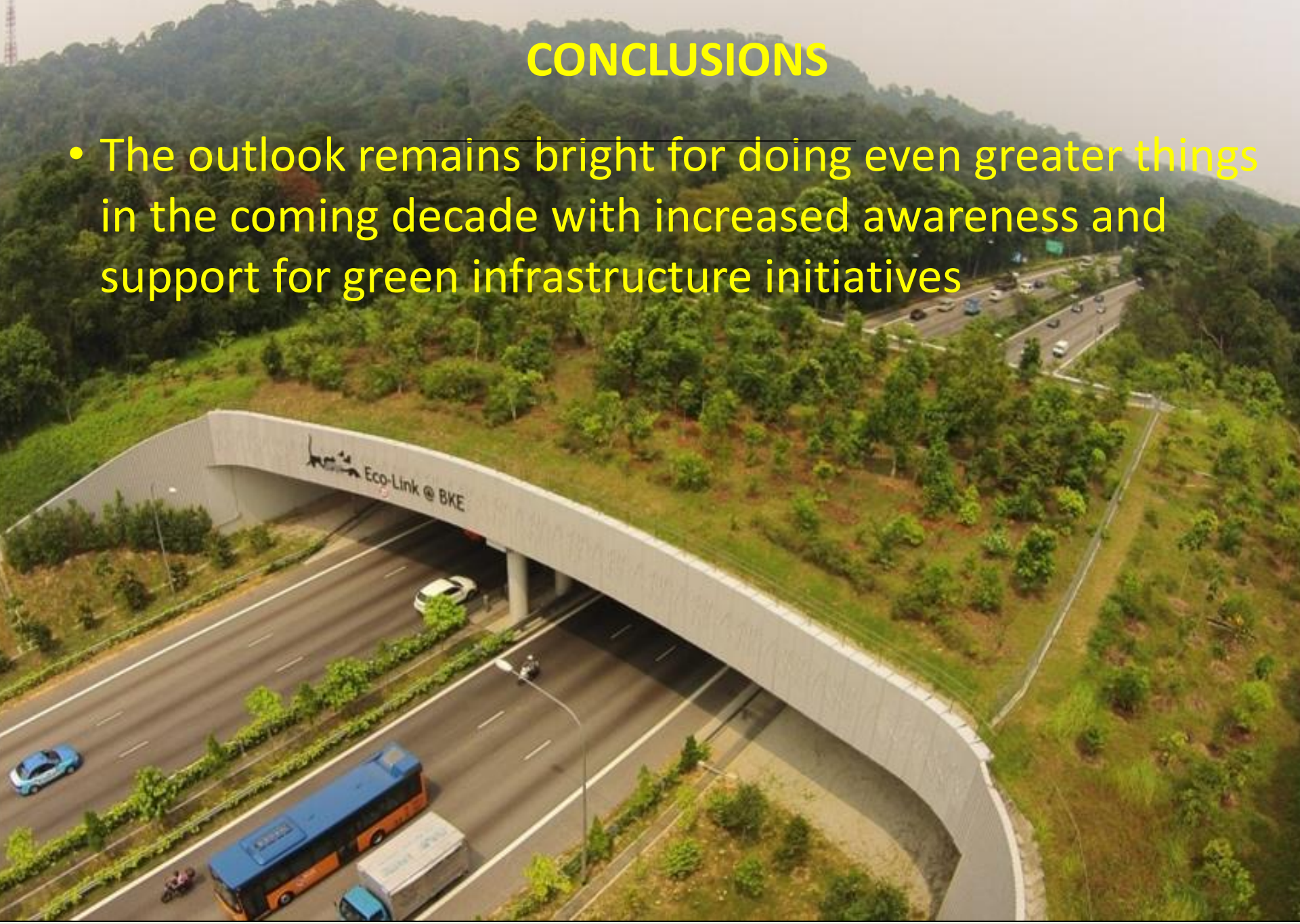


CONCLUSIONS

- The prospect for implementing green infrastructure strategies on Asia's transport infrastructure has dramatically improved in just 5 years
- The outlook remains bright for doing even greater things in the coming decade with increased awareness and support for green infrastructure initiatives
- But this will still require difficult decisions that will require sound project analyses that consider all alternatives in order to tip the balance toward conservation of Asia's remaining biodiversity

CONCLUSIONS

- The outlook remains bright for doing even greater things in the coming decade with increased awareness and support for green infrastructure initiatives



CONCLUSIONS

- But this will still require difficult decisions that will require sound project analyses that consider *all* alternatives in order to tip the balance toward conservation of Asia's remaining biodiversity